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An-2 AIRCRAFT

by

I. V. Radchenko, V. P. Kramchaninov
and V. P. Dubrinskiy

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
(U) AN-2 Aircraft						
(U) AN-2V Aircraft						
(U) AN-2P Aircraft						
(U) AN-2M Aircraft						
Civil Aviation						
Agricultural Aircraft						
Forestry						
Trainer Aircraft						

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An-2 AIRCRAFT

By: I. V. Radchenko, V. P. Kramchaninov and
V. P. Dubrinskiy

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TABLE OF CONTENTS

U.S. Board on Geographic Names Transliteration System....... viii

Chapter I. General Characteristics and Basic Data of Aircraft An-2.. 1

§ 1: Type of Aircraft, Its Purpose and Structural Features.................................. 1

§ 2. Aircraft Strength.................................... 7

§ 3. Materials Applied for Manufacture of the Aircraft.................................... 11

§ 4. Basic Specifications of the Aircraft............ 14

Geometric Data.................................... 14

Control Data...................................... 16

Leveling the Aircraft............................. 18

Weight Data and cg Position of the Aircraft..... 22

§ 5. Flight Characteristics and Specifications....... 33

Aircraft Service Life............................. 35

Chapter II. Construction of the Airframe.................. 37

§ 6. Fuselage.. 37

Fuselage Frame.................................... 39

Fuselage Skin..................................... 57

Wing Center Section.............................. 62

Cockpit Canopy.................................... 65

Standard and Auxiliary Equipment of the Fuselage Compartments.......................... 67

§ 7. Wing Cell.. 77

Upper Wing.. 78

Lower Wing.. 105

Biplane Strut..................................... 108

Wing Cell Wire Strips............................. 110

Fillets... 112

§ 8. Tail Surface....................................... 113

Stabilizer.. 113

Elevator.. 120

Fin... 124

Rudder.. 128

Chapter III. Takeoff and Landing Devices.................. 134

§ 9. Landing Gear....................................... 134

Hinged Joints of the Landing Gear................. 135

Struts.. 136

Semiaxle.. 138

Shock Absorber.................................... 141

Landing Gear Wheel................................ 151

§ 10. Tail Wheel Installation........................... 156

§ 11. Landing Gear Skis................................. 165

§ 12. Pneumatic System.................................. 169

Units of Pneumatic System......................... 171

Chapter IV. Aircraft Control.............................. 184

§ 13. Control-Wheel Assembly.......................... 185

§ 14. Foot Control Pedals............................. 190

§ 15. Control Run of Ailerons and Directional Controls........................ 193

§ 16. Flap Control.................................... 201

§ 17. Trim-Tab Control................................ 205

§ 18. Brake Control................................... 206

§ 19. Adjustment of Aircraft Control.................. 207

Adjustment of Elevator Control.................. 208

Adjustment of Rudder Control.................... 209

Adjustment of Aileron and Flap Control......... 209

Adjustment of Brake Control..................... 213

Chapter V. Power Plant.................................... 215

§ 20. ASh-62IR Engine................................. 215

§ 21. Automatic Propellers V-509-D9A, AV-7N-161 and AV-2.................................... 225

Propeller V-509-D9A with Wooden Blades......... 225

AV-7N-161 Propeller with Metal Blades.......... 229

AV-2 Propeller.................................. 231

§ 22. Engine Mount.................................... 234

§ 23. Propeller Spinner and Engine Cowling........... 239

Propeller Spinner............................... 239

External Engine Cowling......................... 241

Oil Cooler Duct................................. 245

Inner Engine Cowling............................ 246

§ 24. Carburetor Air Intake System.................... 250

§ 25. The Exhaust System.............................. 253

§ 26. Cooling the Engine Components.................. 257

§ 27. Fuel System...................................... 259

§ 28. Oil System....................................... 277

§ 29. Engine Starting System........................... 287

§ 30. Engine, Cowl Flap and Oil Cooler Flap Control.. 290

Engine Control.................................. 290

Cowl Flap Control............................... 300

Oil Cooler Flap Control......................... 301

§ 31. Fire-Extinguishing Equipment.................... 301

Chapter VI. Special Equipment of Aircraft An-2, An-2V and An-2P.. 305

§ 32. Electrical Equipment............................ 305

§ 33. Sources of Electric Power and Controlling Devices.. 307

Aircraft Generator GSN-3000..................... 307

Storage Battery 12A-30.......................... 310

Carbon Voltage Regulator R-25AM................. 313

Differential Undercurrent Relay DMR-400D....... 315

Centralized Single-Phase Alternating Current System.................................. 320

Centralized Three-Phase Alternating Current System.................................. 322

§ 34. Electric Power Consumers........................ 324

Engine Starting Units........................... 325

Remote Control Electrical Mechanisms........... 329

Lighting Equipment.............................. 340

Fire Warning System SSP-2A...................... 349

Electrical System of the Aircraft.............. 352

§ 35. Radio Equipment of An-2 Aircraft.............. 357

Radio Set RSB-5................................ 357

Radio Receiver US-9DM.......................... 373

Radio Set RSIU-3M.............................. 380

Automatic Radio Compass ARK-5.................. 386

Radio Altimeter RV-2........................... 399

Marker Radio Receiving Equipment MRP-56P....... 406

Aircraft Intercom Device SPU-5................. 409

Aircraft Intercom Device SPU-6................. 412

§ 36. Instruments of An-2 Aircraft.................. 422

Instruments Monitoring Engine Operation........ 426

Flight and Navigation Instruments.............. 438

Chapter VII. Special Equipment on the An-2M................ 498

§ 37. Electrical Equipment.......................... 498

§ 38. D-C Sources of Electrical Energy.............. 499

VG-7500 Helicopter Generator................... 499

12SAM-28 Storage Battery....................... 505

Airport D-C Sources of Electric Power.......... 507

§ 39. A-C Sources of Electric Power................. 508

PO-250 Converter............................... 508

PT-125Ts Converter............................. 509

D-C Electrical Power Distribution.............. 510

Control of the Sources of Electric Power During Flight.. 511

§ 40. D-C Consumers of Electric Power............... 512

Peculiarities of Starting the Engine........... 514
Electrical Mechanisms of Remote Control........ 514
The System for Signalling of Fire SSP-6........ 518
Electrically Heated Glasses.................... 520
Electrical Windshield Wiper AS-2............... 521
Airborne Conditioner........................... 522
DV-302T Fan.................................... 524
The Electromagnetic Switch for Locking the Rear Wheel...................................... 524
Control of Agricultural Equipment.............. 525
§ 41. Radio Equipment on the An-2M Aircraft.......... 528
Command VHF Radio Set.......................... 529
Communications Radio Set R-842................. 530
Automatic Radio Compass ARK-9.................. 530
Control of the ARK-9 Radio Compass............. 532
Turning and Tuning the ARK-9................... 534
Radio Altimeter RV-U........................... 535
§ 42. Instrument Equipment of the An-2M Aircraft..... 538
Instruments Monitoring Engine Operation........ 541
Flight and Navigation Instruments.............. 541
Auxiliary Instruments.......................... 542
Chapter VIII. Agricultural Equipment.......................... 545
§ 43. General Information............................ 545
§ 44. The Basic Performance Data..................... 551
§ 45. Description of the Construction of Units....... 552
§ 46. Control of Agricultural Equipment.............. 570
§ 47. Care of Agricultural Equipment and Its Maintenance During Operation................... 578

Care of the Duster............................ 578

Care of the Sprayer........................... 580

Chapter IX. **Storage and Care of the Aircraft**............... 583

§ 48. Tying Down the Aircraft........................ 583

§ 49. Measures for Protection of Aircraft Components and Parts from Corrosion...................... 588

§ 50. Care of the Metal Covering of the Aircraft..... 592

Flaw Detection of the Metal Covering........... 592

Repair of Fuselage Covering................... 593

§ 51. Care of the Fabric Covering of the Aircraft.... 595

Care of the Paint Coating..................... 595

Repair of Fabric Covering..................... 598

§ 52. Care of Windows of the Compartments........... 603

§ 53. Positioning of the Aircraft of Jacks........... 603

§ 54. Towing the Aircraft........................... 605

Chapter X. **Modifications of An-2 Aircraft**................ 609

§ 55. An-2V Seaplane................................ 609

Basic Specifications.......................... 610

Structural Distinctions of the An-2V Aircraft from the An-2................................... 614

§ 56. An-2P Fire-Fighting Aircraft.................. 624

The Design Features of the An-2P Aircraft...... 625

Fire-Fighting Equipment....................... 625

§ 57. An-2M Aircraft................................ 628

Basic Technical Data.......................... 631

The Structural Distinctions of the An-2M Aircraft from the An-2........................ 640

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

The book contains the basic flight characteristics and specifications of the An-2 aircraft and its modifications: An-2V, An-2P and An-2M. Considerable space is allotted to the questions of flight operations of the aircraft and its equipment, there are examined the reasons for possible failures, the methods of their determination, means of elimination and prevention. The description of the construction of units of the aircraft, its systems and special equipment has been given as applies to aircraft of the latest production.

During preparation of the third edition of the book the authors were guided by the appropriate documents and by materials of the manufactuer, and they also consider the experience of operation of the An-2 aircraft, and its modifications on the local airlines of civil aviation, in agriculture and forestry.

The book is intended for pilots and technical engineers of the operational enterprises of civil aviation and other departments. It can also be used as a training aid for schools and academies of civil aviation and the All-Union Voluntary Society for Assistance to the Army, Air Force and Navy of USSR [DOSAFF] (ДОСААФ). Figures 222, Tables, 24.

Chapters I, II, III, IV, V, VIII, IX and X were written by I. V. Radchenko, Sections 32, 33, 34, 35 of Chapter VI and Sections 37, 38, 39, 40 and 41 of Chapter VII - V. P. Kramchaninov, Sections 36 and 42 of Chapters VI and VII - V. P. Dubrinskiy

CHAPTER I

GENERAL CHARACTERISTICS AND BASIC DATA OF AIRCRAFT An-2

§ 1. TYPE OF AIRCRAFT, ITS PURPOSE AND STRUCTURAL FEATURES

The An-2 aircraft (Fig. 1) of the general designer's construction according to the aircraft technique of the Hero of Socialist Labor O. K. Antonov - biplane type, with ASh-62IR engine and AV-2 propeller is used on local airlines as a passenger and cargo aircraft. With wheel-type and ski landing gear - it is designed for transportation in the cargo version, depending on the flying range, of different types of cargo weighing up to 1500 kg, and in the passenger version - up to 12 passengers. During the winter period with sufficient thickness of snow cover the aircraft is equipped with skis (Fig. 2) and is allowed to operate with free-air temperatures to minus 45°C.

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Fig. 1. An-2 aircraft with wheel-type landing gear.

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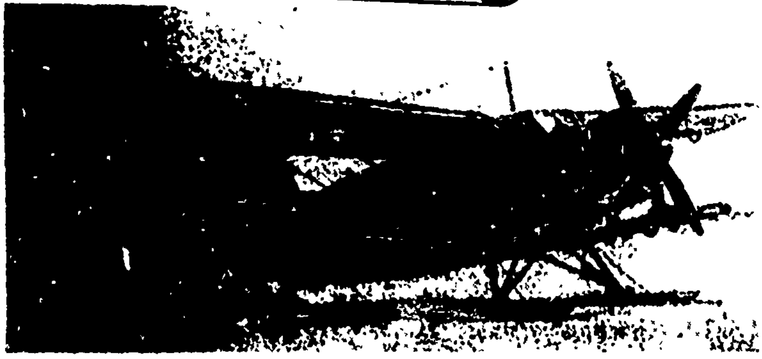

Fig. 2. An-2 aircraft with ski landing gear.

With little conversion the An-2 aircraft can be used for the following purposes:

1) for combating agriculture and forestry pests, weedy vegetation, for applying fertilizers to the soil, defoliation and the desiccation of cotton and other operations (the agricultural version);

2) for utilization in the air medical service (ambulance version);

3) for aerial survey and geophysical operations;

4) for the protection of forests and the extinguishing of forest fires.

The An-2 aircraft - metal construction with fabric covering of wings and tail section.

Fuselage - semimonocoque type of all-metal construction. The dual-control cockpit is enclosed by a spacious glass-fitted canopy with a good forward and downward view. Behind the cockpit is located the cargo compartment, in which along the sides of the fuselage are 12 collapsible seats.

For the transportation of passengers in the compartment are installed 12 passenger seats, arranged facing the nose of the aircraft or at a 45° angle to its longitudinal axis.

The cargo compartment 4.2 × 1.85 × 1.65 m in size, with total volume about 12 m^3, allows transporting cargo of large overall dimensions. For loading cargo into the aircraft on the left side of the fuselage is located a door 1.53 × 1.46 m in size, in which there is installed a passenger door 1.42 × 0.81 m in size. The floor of the cargo compartment is designed for a concentrated load of 1000 kg/m^2.

Both compartments are equipped with suction and exhaust ventilation and are heated with warm air.

The biplane wing cell is of single-strut type. Each half-cell consists of upper and lower wings, biplane strut and wire strips: two supporting and three lift.

The wings of the aircraft are of metal construction with constant spanwise profile, fitted with a stretched fabric covering.

On every detachable part of the upper wing are installed:

slotted ailerons with aerodynamic nose balance and mass balancing;

slotted flaps with aerodynamic nose balance;

along the entire wing span - automatic slats.

The ailerons are deflected differentially - upward to 30° and down to 14°. Aileron control is connected with flap control, i.e., interlocked by the aileron droop mechanisms with flap deflection downward. When such locking exists, during flap deflection downward to 40° the ailerons are deflected down (they droop) to 16° and work as flaps.

On the left aileron is installed a trim tab, which is controlled from the cockpit with the aid of a UT-6D electrical mechanism.

On every detachable part of the lower wing, along the whole span, there are installed two slotted flaps each (root and cantilever) with aerodynamic nose balance. Flap control is electrical remote and is accomplished from two UZ-1AM electrical mechanisms, arranged on the upper and lower parts of fuselage frame No. 8.

The powerful high-lift device of the wings allows operating the An-2 aircraft on small airfields and ensures its stable gliding at high angles of attack.

Tail assembly - single tail-fin with highly placed semicantilever stabilizer, consists of metal framework and fabric covering. The stabilizer is the longitudinal stability element of the aircraft, has rectangular planform with rounded tips and symmetrical constant profile along the whole span.

The elevator and rudder have aerodynamic forward balance and mass balancing. On the rudder spar and at the leading edge of the left half of the elevator are installed trim tabs with electrical remote control by UT-6D electrical mechanisms.

The landing gear is of the fixed, pyramid type. Each half of the landing gear consists of a shock strut, forward and rear bracing struts, half-axle and brake wheel (in winter brake skis are installed).

The wheel brakes are of the drum type. The braking device of the ski consists of a base, milled out of aluminum alloy, in the bearings of which is mounted a shaft with seven studs. The studs emerge from the ski and are buried in the snow cover to a depth up to 45 mm. Brake control is accomplished from the overall air system with the aid of a button located on the aircraft commander's control wheel.

The tail strut of the aircraft (installation of the tail wheel) is mounted on fuselage frame No. 23 and consists of a steel truss, the cylinder of fork (coupling pin) with centering device, wheel forks, brakeless baloon tire and shock strut. On aircraft of Polish People's Republic [PNR] (ПНР) production the installation of the tail wheel has been modernized and it differs structurally from the tail strut described above.

Aircraft control is dual. The command hand and foot controls are located side by side in the cockpit. The control run of the ailerons and elevator is rigid cable; the rudder control run - cable. On the aircraft is installed an ASh-62IR nine-cylinder air-cooled engine and an AV-2 four-blade automatic propeller with metal blades.

For feeding fuel and oil to the engine there are systems on the aircraft. The fuel feed system of the engine consists of six tanks with total capacity 1200 liters, located in the upper wing, lines, units and fittings. The oil system consists of one tank with capacity 125 liters, located at fuselage frame No. 1, air-oil cooler, lines and fittings.

Engine and fuel cock control is mechanical. Control of the cowl flaps and the oil cooler tunnel ducts - electrical remote and is accomplished from UR-7 electrical mechanisms.

Electric power sources on the aircraft are GSN-3000 generator and 12A-30 battery (standby source). The wiring is basically a single-wire circuit with grounding of negative wires to the mass of the aircraft. For reduction of radio reception interference and increase of fire safety the aircraft is completely metallized, reliable connection of all metal parts of the aircraft, components and equipment together is provided for.

The aircraft is equipped with radio equipment for orientation and communication with ground stations, and also with instruments for flight outside ground visibility and landing in severe weather conditions.

The An-2 aircraft possesses sufficiently good takeoff and landing characteristics and high flight-performance data. It has a large margin of directional and longitudinal stability on the entire cg range from 17.2 to 33% of mean aerodynamic chord [MAC]. The indicated cruising speed of the aircraft in horizontal flight - within limits from 147 to 210 km/h.

A distinctive feature of the An-2 aircraft is the combination of comparatively great flying range and load capacity with good takeoff and landing data, which facilitates its operation on small airfields and landing areas (650 × 200 m), which is especially important when performing aviation and chemical operations.

With removal of agricultural equipment from the aircraft it is used as a transport plane in the cargo version.

Cost of a ton-kilometer on the An-2 aircraft is lower than on the Li-2 aircraft, especially in flights at a distance up to 1000 km.

The An-2 aircraft was series produced since 1949 and in the twenty-year service life it was widely used in the national economy: for the transportation of passengers, mail, various cargo, on aviation and chemical operations, aerial photography and geophysical prospecting, for the protection of forests and the extinguishing of fires and for other special purposes. The following modification of the An-2 are in operation:

1) An-2V seaplane on float-type landing gear;

2) An-2P fire-fighting aircraft;

3) An-2M agricultural aircraft.

§ 2. AIRCRAFT STRENGTH

The ability of the aircraft to withstand external loads acting on it in flight without failure and the appearance of permanent deformations is called the aircraft strength.

Under various flight conditions the structure of the aircraft experiences three types of load: from the weight of the aircraft, during flight in bumpy air (in bumpiness) and load during maneuver, i.e., with sharp pullout of the aircraft. The ratio of lift Y to the weight of the aircraft G is called overload and is designated n

$$n = \frac{Y}{G}.$$

The degree of lift increase during various flight conditions of the aircraft is determined by the operational load factor $n_э$.

In horizontal steady flight lift is equal to the weight of the aircraft (Fig. 3), consequently, the operational load factor is equal to one

$$n_э = \frac{Y}{G} = 1.$$

During flight in disturbed flow (Fig. 4) the aircraft is affected by horizontal and vertical air flows, which, changing the angles of attack of the wing, convert the flight of the aircraft from horizontal to curvilinear, i.e., against the will of the pilot create aircraft overload more than one.

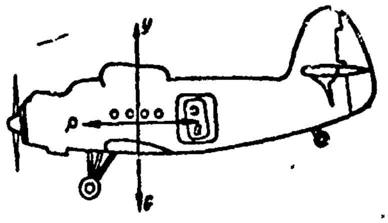

Fig. 3. Diagram of the forces affecting the aircraft in horizontal flight.

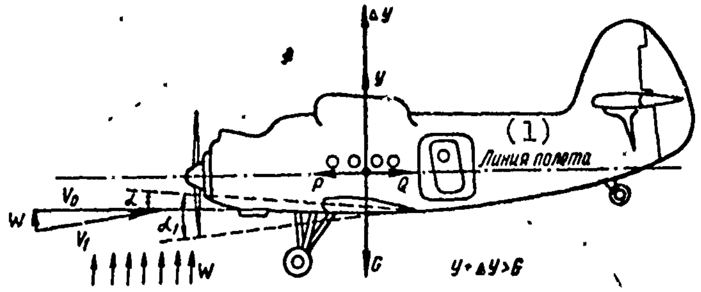

Fig. 4. Flight in air flow and the appearance of overloads: α - angle of attack before the action of vertical flow; α_1 - angle of attack during the action of vertical flow; W - vertical air flow; ΔY - lift increment

KEY: (1) Line of flight.

When determining the maximum permissible operational overload of any aircraft we proceed from the condition that stresses appearing in the structural elements would not exceed the proportional limit, i.e., that there would not be permanent deformations in the structure of the aircraft.

For the An-2 aircraft the maximum operational overload is equal to 3.74. For the purpose of maintaining the maximum operational overload established for the aircraft the speed during descent should not exceed 220 km/h during flight in still air, and during flight in bumpiness - 190 km/h. The maximum allowable indicated flight speed is 250 km/h.

The overload, at which failure of the aircraft structure occurs, is called the ultimate or design and is designated n_p. Ultimate overload is always greater than operational.

The number, which shows how many times the ultimate load factor is greater than the operational overload factor, is called the safety margin or safety factor and is designated by the letter f. The greater the safety factor, the higher is the aircraft strength.

A certain minimum value of safety factor is established, so that at maximum permissible operational overload the stresses in the structural elements would not cause permanent deformations.

For nonmaneuverable aircraft the safety factor f = 1.5. For the An-2 aircraft the maximum ultimate or design overload factor will be

$$n_p = n_{\text{э}} \times f_1 = 3{,}74 \times 1{,}5 = 5{,}61.$$

The An-2 aircraft belongs to the 4th class of transport planes. Its gross weight G = 5500 kg.

The ultimate overload given above is determined from the strength conditions of the wing cell. All the remaining aircraft components (fuselage, tail section, engine mount and others) are strength computed from the results of static tests and have a somewhat greater safety margin than that accepted in calculation.

The strength of the landing gear of the An-2 is determined by stress standards, which several calculated cases have provided. For each calculated case depending on the landing speed and gross weight there is established a maximum permissible operational overload. For the wheel-type landing gear of the An-2 - 2.66, for ski landing gear - 2.5 and for float-type landing gear - 3.14. During these overloads permanent deformations should not appear in the structural elements of the landing gear.

The safety factor for the landing gear and floats is equal to 1.65. Ultimate overload for the structural elements of wheel-type landing gear $n_p = n_{э.max} \times f = 2.66 \times 1.65 = 4.39$ and for floats $n_p = 3.14 \times 1.65 = 5.18$.

The shock absorption of the landing gear is also selected from conditions of loads, the magnitudes of which are determined depending on the landing speed and the gross weight of the aircraft.

There exists the concept of so-called "normalized stroke," which is equal in magnitude to the kinetic energy being developed with shock, if we drop an aircraft with normal gross weight from a height of 0.8 m. The normalized stroke is determined by formula

$$A_{норм} = \frac{MV_y^2}{2},$$

where $M = \frac{G}{g}$ - the aircraft mass; V_y - the vertical velocity of the aircraft at the moment of its ground contact, determined from stress standards.

During absorption of the "normalized stroke" during impact by the shock struts and the pneumatic tires of the wheels, at the moment of maximum compression of the pneumatic tires, the appearing overloads should not exceed the maximum permissible operational overload for the landing gear $n_{э.max} = 2.66$.

The landing gear shock absorption absorbs stroke $A_{э.норм} = 974$ kgf-m with overload $n_э = 2.1$; maximum "normalized stroke" $A_{норм.max} = 1720$ kgf-m when $n_э = 2.66$ (the total stroke of the shock strut). With selection of the pneumatic tires and shock struts we consider that the pneumatic tires should absorb about 40% and shock absorbers about 60% of the "normalized stroke."

A sufficient safety margin of the landing gear, the presence of soft hydropneumatic shock absorption and semi-baloon type wheels ensure pancake landing.

§ 3. MATERIALS APPLIED FOR MANUFACTURE OF THE AIRCRAFT

For the manufacture of the main load-bearing elements of the airframe D16T and D16AT brands of duralumin are used.

The code of duralumin designates:

D - duralumin;
16 - number of alloy.

The following conventional designations can be encountered in the code of duralumin:

A - high-quality duralumin;

M - soft, annealed;

T - heat-treated, having underwent hardening and natural aging.

N - cold-worked;

V - with increased quality of rolling.

For corrosion protection the duralumin is clad with a thin layer of pure aluminum or is coated with a film of anode oxidizing.

The mechanical properties of sheet alclad D16 have been given in Table 1.

Table 1.

Brand of material	Ultimate strength σ_{sp}, kg/mm^2	Relative elongation σ, %
D16AM.......	Not over 24	12
D16AT, D16ATV......	41-43	13-11
D16ATN, D16ATNV.....	42-46	10-8

The internal joints of the airframe structure, brackets, aircraft control actuating arms are manufactured by casting from aluminum alloys AL4 and AL9 or by stamping from alloy AK6. The numbers in the alloy codes designate the number of the alloy, and letters AL - foundry aluminum, AK - aluminum for forging.

Besides aluminum alloys, in aircraft construction there are used magnesium alloys ML4 and ML5. Alloy ML4 is for the manufacture of parts being subjected to static loads. This alloy possesses good anticorrosive properties (after oxidizing), however it has insufficient castability. Alloy ML5 possesses high castability and is used for the manufacture of wheel drums, control columns, foot control pedals, the cockpit canopy framework and others.

The most loaded parts and joints of the An-2 aircraft are manufactured from chromium-manganese-silicon steel of brand 30KhGSA, heat-treated to $\sigma_{\text{вр}} = 140 \pm 10$ kgf/mm^2. Chromansil steel is welded well by arc welding and satisfactorily - by other types of welding.

Wire strips, shafts and couplings for them are made from 45A medium-carbon steel, which after quenching and tempering has $\sigma_{\text{вр}} = 70\text{-}90$ kgf/mm^2 and $\delta \geq 11\%$.

The separate joints, bolts, nuts and other parts are made from mild steel of brands, 20, 20A and 25. Steel 25 has $\sigma_{вр} \geq$ ≥ 43 kgf/mm^2 and $\delta \geq 18\%$.

The small number of parts which are in elevated temperature zones and are subject to wear are manufactured from high-temperature stainless steel of brand YalT, which ensures the operation of parts at a temperature up to 900°C. In the code of this steel the letter Ya conditionally designates chrome-nickel stainless steels: the letter T - the presence of titanium in the alloy, increasing the heat resistance of steel; 1 - the number of the alloy.

For the manufacture of fuel and oil tanks used AMtsA alloy is used, having $\sigma_{вр} = 13$ kgf/mm^2 and $\delta = 20\%$. For the manufacture of lines there is used alloy AMgM with $\sigma_{вр} = 20$ kgf/mm^2 and $\delta = 23\%$. These alloys are welded well, are resistant to corrosion, allow stamping in cold state, but have insufficient mechanical properties.

For the covering of wings and the tail section we use AM-93 cotton aircraft linen (mercerized aircraft fabric), having mean breaking strength not less than 70 kgf and elongation not more than 13%.

The aircraft control rollers are made from textolite.

The glass of the cockpit canopy and the cargo compartment is made from organic glass - plexiglas.

§ 4. BASIC SPECIFICATIONS OF THE AIRCRAFT

Geometric Data

Linear dimensions (Fig. 5)

Aircraft length, m:	
in the line of flight	12.735
when parked	12.4
Height of the aircraft, m:	
in the line of flight	5.35
when parked	4.13
Biplane wing span, m:	
upper wing	18.176
lower wing	14.236
Span of the detachable part of the upper wing, m	8.425
Chord of the detachable part of the wing (with depressed slat), m:	
with respect to the flap	2.4
with respect to the aileron	2.45
Span of the detachable part of the lower wing, m	5.795
Chord of the detachable part of the wing, m	2.0
Aspect ratio, m:	
upper	7.7
lower	7.25
Span of horizontal tail surface on aircraft, m:	
up to 60 series	6.6
after 60 series	7.2
Chord of horizontal tail surface, m	1.8
Stabilizer chord, m	1.05
Span of upper wing slats, m	7.7
Aileron span, m	4.692
Aileron chord, m	0.65
Span of aileron trim tab, m	1.18
Trim tab chord, m	0.12
Span of upper wing flap, m	3.415
Chord of flap, m	0.6
Span of lower wing flaps, m:	
root	3.16
tip	2.452

Chord of flaps, m	0.5
Elevator span on aircraft, m:	
up to 60 series	6.464
after 60 series	6.946
Elevator chord, m	0.74
Span of elevator trim tab, m	1.778
Span of vertical tail surfaces, m	3.35
Rudder span, m	3.285
Rudder chord (the greatest), m	1.355
Span of rudder trim tab, m	0.838
Fuselage length, m	10.120
Fuselage width, m	1.80
Fuselage width along center section, m	2.6
Height of fuselage in the line of flight, m	2.521
Landing gear wheel track with free shock absorbers, m	3.36
Distance between main landing gear wheels and tail wheel, m	8.23
Size of landing gear wheels, mm	800 × 260
Size of tail wheel, mm	470 × 210
Length of landing gear ski, m	2.662
Width of ski, m	0.825
Length of tail skid, m	1.211
Width of skid, m	0.5
Cargo compartment dimensions, m:	
length	4.2
width	1.65
height	1.85
Overall cubic capacity, m^3	12
Door dimensions, m:	
cargo	1.53 × 1.46
for passengers	1.42 × 0.81
Diameter of cargo compartment window, mm	320

Areas of the aircraft

Wing cell area with ailerons and flaps, m^2	71.51
Area of upper wing with ailerons and flaps, m^2	43.55
Area of lower wing with flaps, m^2	27.96
Area of the wing cell units, m^2:	
ailerons	5.9

upper wing flaps	4.09
root flaps of the lower wing	3.15
tip flaps of the lower wing	2.348
aileron trim tab	0.141
Horizontal tail surface area of aircraft before 60 series, m^2:	
total area	11.38
stabilizer	6.99
elevator	4.392
Horizontal tail surface of aircraft after 60 series, m^2:	
total area	12.28
stabilizer	7.56
elevator	4.72
Area of elevator trim tab, m^2:	0.268
Vertical tail surface area, m^2	5.85
Fin area, m^2	3.2
Rudder area, m^2	2.65
Rudder trim tab area, m^2	0.116
Bearing surface of the main landing gear skis, m^2	2.18
Bearing surface of the tail skid, m^2	0.6
Fuselage midsection area, m^2	3.84
Specific pressure on the main ski depending on the gross weight of the aircraft, kgf/cm^2	from 0.09 to 0.11
Specific pressure on the tail skid, kgf/cm^2	from 0.115 to 0.16

Control Data

Dihedral:	
upper wing	3°
lower wing	4°19'
Stabilizer dihedral	0°
Setting angle:	
upper wing	3°
lower wing	1°
Stabilizer setting angle on aircraft:	
up to 60 series	minus 1°54'
after 60 series	" 1°
Wing and stabilizer sweep	0°
Aircraft stalling angle	11°50'
Antinose-over angle	28° ± 1°

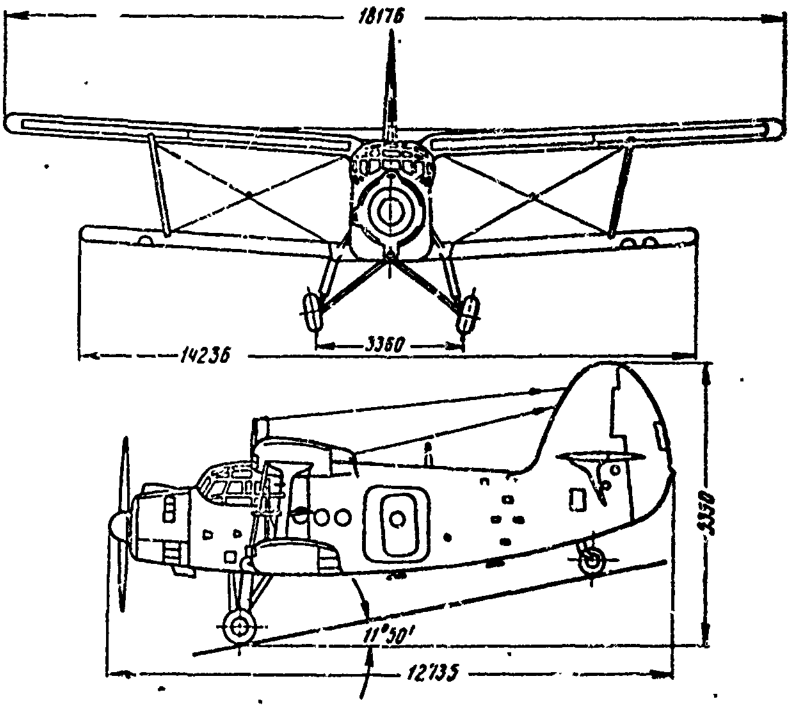

Fig. 5. Configuration of An-2 aircraft with wheel-type landing gear. Front and side view.

Control deflection is provided in Table 2.

Table 2.

Controls	Deflection α, deg		Deflection f, mm	
	up	down	up	down
Ailerons.................	$30^{+1}_{-1,5}$	$14^{+1}_{-1,5}$	$263,5^{+8}_{-13}$	124^{+8}_{-13}
Upper wing flaps.........	—	$40^{+1}_{-1,5}$	—	320^{+8}_{-13}
Lower wing flaps.........	—	$40^{+1}_{-1,5}$	—	268^{+7}_{-11}
Aileron droop with flaps down to 40°...................	—	$16^{+1}_{-1,5}$	—	$141,5^{+8}_{-13}$
Ailerons with drooped flaps 40°.............	$12^{+1}_{-1,5}$	$30^{+1}_{-1,5}$	106^{+8}_{-13}	$263,5^{+8}_{-13}$
Aileron trim tabs........	24^{+5}_{-1}	24^{+5}_{-1}	52^{+10}_{-5}	52^{+10}_{-5}
Elevator from 0 to 33 series inclusively.....	35±1	18±1	344±10	178±10
Elevator on aircraft:				
from 34 to 59 series...	35±1	22°30'±1°	344±10	224±10
from 60 series.........	42^{+3}	22°30'±1°	409^{+36}	224±10
Elevator trim tab........	14∓1	14±1	37±2	37±2
Rudder (take measurement according to rib No. 6...	28^{+2}_{-2}	28^{+1}_{-2}	393^{+13}_{-28}	393^{+13}_{-28}
Rudder trim tab..........	14±1	14±1	—	—

Leveling the Aircraft

The aircraft is leveled during joining of the airframe parts. The assembled aircraft is positioned in the line of flight. With this the tail is raised to a height of about 2 m and a screw jack is placed under the support at frame No. 26.

For safety before lifting the tail of the aircraft in the area of frame No. 20 on a zone 120 mm wide there is suspended a load of not less than 50 kg. Under the center section are placed two screw jacks and they are installed under the supports located in the bottom part of frame No. 6.

Positioning the aircraft in the line of flight. The positioning of the aircraft in the line of flight is checked by a leveling instrument and by a scale for fixed points, established on the sides of the fuselage. The fixed points are painted red, are located on frames Nos. 4 and 22 of the fuselage at a distance of 900 mm from the axis of the attachment joints (20.5 mm higher than the horizontal datum line of the aircraft). By rotation of the screw jacks we achieve arrangement of the three fixed points in one plane, which attests to the positioning of the aircraft in the line of flight.

It is possible to position the aircraft in the line of flight even by the clamp bolts of the lower wing with the center section, for which it is necessary to remove the fairings. On an aircraft positioned in the line of flight both clamp bolts (their axes), forward and aft, lie in one plane, which is checked by the leveling instrument and the rule.

Leveling and adjustment of the wing cell. After positioning the aircraft in the line of flight the biplane cell is leveled and adjusted. The wings are installed according to fixed points on the forward and aft spars, ribs Nos. 2 and 17 of the upper wing (across the lower surface) and ribs - Nos. 2 and 14 of the lower wing (across the upper surface).

The setting of wing dihedral angles is performed in the process of tightening the wire strips of the biplane cell. The degree of tension of wire strips is given in Table 3.

Table 3.

Point of installation of strip	Designation	Tension limit, kfg
Forward load-carrying strip (paired)	Wire No. 14 GOST 1004-48	600-1100
Aft load-carrying strip	Wire No. 14 GOST 1004-48	740-1100
Supporting strip (paired)	Wire No. 11 GOST 1004-48	900-1300

On An-2 aircraft of PNR production the tension of wire strips (All-Union State Standard [GOST] (ГОСТ) 1004-48) of the biplane cell according to bulletin No. E/260/419/62 and to maintenance regulations of the An-2 aircraft, approved by the Ministry of Civil Aviation of the USSR, should be within the following limits:

1) strip No. 11 forward (supporting):
right - 1180-1320 kgf, left - 1240-1380 kgf;
strip No. 11 aft (supporting):
right - 1200-1330 kgf, left - 1240-1380 kgf;

2) strip No. 14 forward (load-carrying):
right - 580-740 kgf, left 600-780 kgf;
strip No. 14 aft (load-carrying);
right - 580-740 kgf, left - 600-780 kgf;

3) strip No. 14 aft - (trailing edge of wing) load-carrying:

right - 750-870 kgf; left - 760-870 kgf.

It is necessary to observe the following order and method of adjustment of wire strips of the biplane cell:

1) stretch strips No. 11 so as to guarantee the required wing dihedral by the leveling plane;

2) increase the tension of the forward strips to the magnitude indicated in the data given above;

3) increase the tension of the aft strips No. 14 to the magnitude indicated in the data give above.

All the above-enumerated operations on the tightening of wire strips of the wing cell are performed by the forces and facilities of operational enterprises.

At the above-indicated tension limits of wire strips of the wing the dihedral angles should be: lower wing +4°19', upper +3°. The exceeding of angles is checked by a leveling instrument and rule at the fixed points. After checking the dihedral angles we adjust the wing setting angles by adjusting screws at the aft attachment angles of the biplane strut.

The wing settings are checked by the leveling instrument and rule. The upper wing is set at angle 3°, lower – 1°.

Note. The total amount of increase of the setting angles of the left half-cell should be 3 mm more than the exceeding of the right, remaining within limits of allowances.

The stagger of the upper wing over the lower is checked by ribs Nos. 2 and 17 of the upper wing by a plumb-line or rule.

Leveling and adjustment of stabilizer. The stabilizer setting angles are checked on the attachment fittings of the stabilizer strut at rib No. 6. The stabilizer is set at negative angle 1°54' to the horizontal datum line on aircraft up to series 59-20.

On aircraft of series 60-01 the stabilizer is set at negative angle 1° to the horizontal datum line of the aircraft.

The setting of the right and left halves of the stabilizer is checked by a leveling instrument and rule at the attachment fittings of the struts.

The difference in the excesses of the right and left halves of the stabilizer from the horizontal datum line with respect to the fittings of the right and left struts should not exceed 5 mm. After leveling we check the symmetry of the right and left parts of the aircraft, for which we compare the diagonal dimensions of the right and left halves.

Upon completion of leveling all the adjustable joints are locked. The data of the linear values on the setting of wings and stabilizer are provided in the official diagrams, applied to each aircraft.

Check of the engine installation. The setting angle of the engine in vertical plane relative to the horizontal datum line of the aircraft should be 0° ± 10'; it is checked by a leveling instrument and a goniometer, installed on the nose of the engine shaft. The axis of the engine coincides with the horizontal datum line of the aircraft.

Lateral misalignment of the engine relative to the horizontal datum line of the aircraft is allowed within ±2.5 mm. Total misalignment of the nose of the engine shaft is allowed within the limits of a circumference with 6 mm diameter. The position of the nose of the shaft is adjusted by turning in or by reversing the yoke joint of the engine mount; the threaded part in this case should not emerge more than 6 mm.

Weight Data and cg Position of the Aircraft

Weight data

The normal gross weight for all versions, kg:	
on routes up to 3000 m above the terrain	5250
on routes more than 3000 m (up to 3800 m) above the terrain	5000
with reinforced landing gear, but without reinforcement of the center section according to bulletin 67-E	5000
with nonreinforced landing gear according to bulletin 67-E	4740
Landing weight, kg	not over 5250
Depending on the version the weight of a starting aircraft is within, kg	3400-3690

(take the actual basic weight from the aircraft logbook).

Loading the Aircraft

The position of the aircraft center of gravity has a large effect on the behavior of the aircraft in air and on its control. Incorrect placement of cargo in the aircraft leads to disturbance of stability and controllability of the aircraft, complicates takeoff and landing, lowers the lift-drag ratio of the aircraft, and unrestrained cargo in the aircraft during takeoff or in flight can shift back to frame No. 15 and lead to sharp disturbance of the cg position of the aircraft, loss of longitudinal stability and to fall of the aircraft into a spin. Therefore, before flight it is necessary to check the correct placement of passengers (especially passengers with children), luggage or cargo and to determine the position of the center of gravity of the loaded aircraft by the cg position charts.

When loading the aircraft (in the cargo version) it is possible to use the green and red marks applied on the right wall of the cargo compartment of the fuselage (Fig. 6). Opposite the green arrow with the inscription "Up to 1500 kg" it is possible to arrange cargo of any weight up to 1500 kg. In this case the cg position in flight will be 24-25% of mean aerodynamic chord [MAC] (CAX) and correspond to the greatest margin of longitudinal static stability of the aircraft without the use of trim tab.

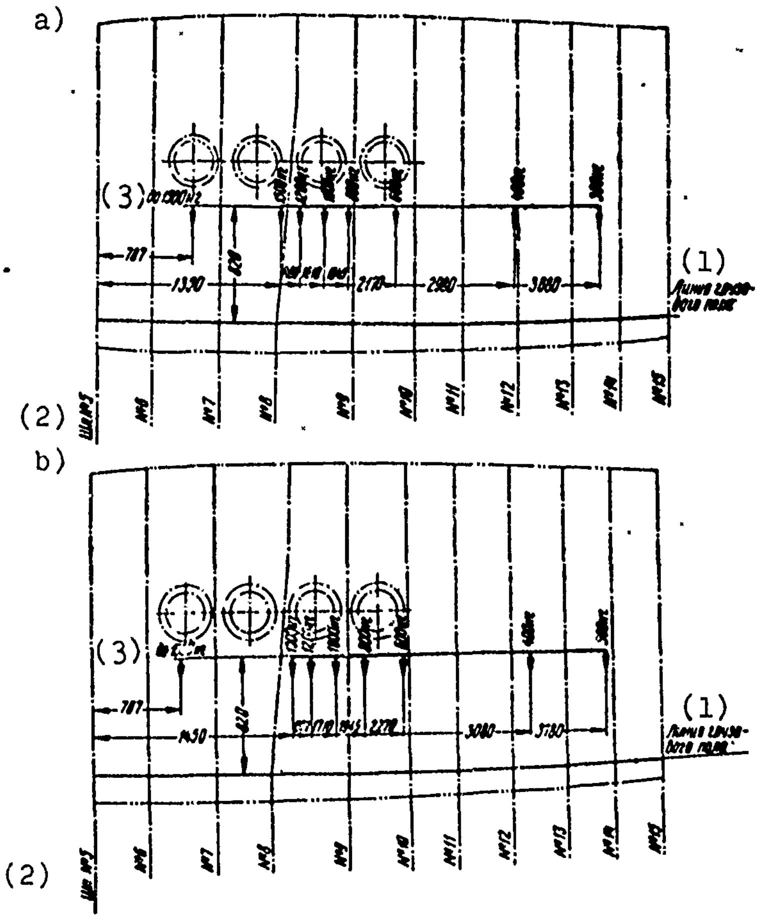

Fig. 6. Marks, applied on the right side inside the cargo compartment, indicating the maximum allowable rear placement of the centers of gravity of cargo: a) on aircraft up to 60 series; b) on aircraft after the 60 series.

KEY: (1) Line of cargo floor; (2) Frame; (3) up to.

Designation: кг = kg

Red pointers with marks 1500, 1200, 1000, 800, 600, 400 and 300 kg show the aft-most position of the center of gravity of the load, in this case the aircraft still has sufficient margin of longitudinal static stability. In this case the cg position is obtained around 33% of MAC, i.e., the aft-most from permissible.

No less important is the fact that the gross weight of the aircraft should not exceed the established standards, since overloading increases the stress in its parts and can lead to failure.

The Placement of Cargo in the Aircraft

In the cargo version the placement of cargo in the aircraft is usually accomplished according to the marks (see Fig. 6) indicated on the right side inside the fuselage in accordance with the An-2 aircraft flight operation and handling manual (general instructions on loading the aircraft), with the required calculation of the cg position in the cg position charts.

Example. One load weighing 600 kg can be located at any point between the green pointer with mark "Up to 1500 kg" and the red pointer with mark "600 kg." If there are several loads, then it is necessary to place them so that their common center of gravity would be located either opposite the red pointer with mark "600 kg," or in front of it right up to the green pointer inclusively.

If the amount of the load does not correspond to the values of numbers applied on the side of the fuselage, for example 650 kg, then it is impossible to place it opposite numbers 600, 400, and 300, since such a placement of the load creates an inadmissible aft cg position, which exceeds 33% of MAC.

Note. The flight of an aircraft at cg position more than 33% MAC is forbidden. It is also forbidden to place a load in the aft section of the fuselage after frame No. 15.

With placement of passengers, luggage, mail and cargo on the aircraft it is necessary to consider that the passengers located in the rear seats, and cargo - placed after frame No. 8 have the greatest effect on the shift of the center of gravity back. Therefore, with partial load of passengers it is necessary to leave the rear seats empty (in all cases seat passengers with children in the front seats), and to place cargo and luggage between fuselage frames Nos. 6 and 8.

The transportation of passengers in the cargo compartment on folding seats is undesirable and is permitted temporarily. At present the individual transport planes, intended for the transportation of passengers, have been re-equipped under the passenger version, where 12 seats are installed (Fig. 7).

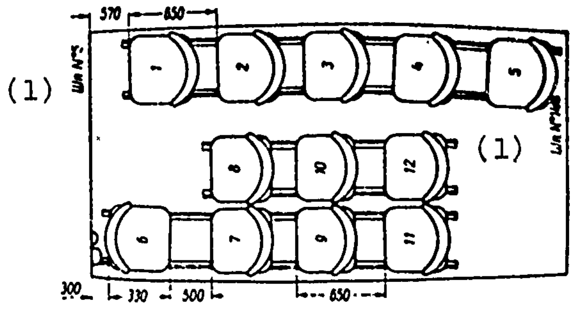

Fig. 7. Configuration of the An-2 aircraft in the passenger version.

KEY: (1) Frame.

After the cargo or passengers in seats are correctly placed, it is necessary to strictly observe the requirements of cargo restraint in the fuselage to prevent their shift during takeoff back to frame No. 15, and also the strapping of passengers to the seats by seat belts for preventing their fall during takeoff and landing.

The Variants of Loading the An-2 Aircraft with 12 Passenger Seats

Variant 1. The loading of An-2 aircraft (from the 60 series of manufacture), on which 12 passenger seats have been installed and 25 kg ballast have been arranged at fuselage frame No. 22, is given in Table 4.

Table 4.

Designation of load	Weight of load, kg
Basic aircraft weight	3367
Fuel	500
Oil	60
Crew	160
12 passengers with weight of seats	954
Luggage at fuselage frame No. 8	120
Installed attachment plates for seats	10.18
Ballast at fuselage frame No. 22	25
Weight of removed flight instrument located at fuselage frames Nos. 21 and 22	-42
Weight of removed equipment (folding seats and two litter attachment devices)	-55.5
Gross weight of the aircraft, kg	5098.68
Aircraft center of gravity position, % MAC	32.9

Variant 2. On An-2 aircraft (from the 60 series of manufacture) in the case of execution of flights without load, with low remainder of fuels and lubricants, with 12 seats and 25 kg ballast located at fuselage frame No. 22, the loading is given in Table 5.

Note. 1. According to the plant equipment list of the An-2 aircraft the basic weight includes the weight of a flight instrument (42 kg) with its location at fuselage frames Nos. 21 and 22.

2. During transportation of 12 passengers and 120 kg of luggage, located at fuselage frame No. 8, 25 kg ballast can be

arranged at any point up to frame No. 22 inclusively, but in flights without load and with small gas and lubricant residue the ballast can be placed only at frame No. 22.

Table 5.

Designation of load	Weight of load, kg
Basic aircraft weight	3367
Fuel	50
Oil	25
Crew	160
Installed attachment plates for seats	10.18
Seats	54
Ballast at frame No. 22	25
Weight of removed flight instrument located at frames Nos. 21 and 22	-42
Weight of removed equipment (folding seats and two litter attachment devices)	-55.5
Gross weight of the aircraft, kg	3593.68
Aircraft center of gravity position, % MAC	18.77

3. During flights with 12 passengers and 25 kg ballast, concentrated directly at frame No. 5, it is permitted to place luggage weighing 120 kg up to fuselage frame No. 12.

Balance ta and Check of the Position of the ter of Gravity of a Loaded Aircraft

Table 6 contains balance data of the aircraft: extreme allowable cg position in flight in % MAC, the cg position of basic aircraft % MAC, and also obtained by conversion of the distance of the center of gravity of an empty aircraft from frame No. 7 in meters.

Any relocation of the installation of equipment, performed by the operating concerns, or change of its layout can considerably change the cg position of the empty aircraft. In these cases the cg position must be considered by conversion, as shown below in the examples of the calculation of cg position. The recommended cg range, which ensures the easiest aircraft control, is 23-28% MAC.

Table 6.

Balance data of the aircraft	Series of aircraft				
	to 36-20	from 37-01 to 59-20	from 60-01 to 63-20	from 64-01 to 71-20	from 72-01
Maximum operational cg position, % MAC:					
forward......................	19.2	19.2	17.2	17.2	17.2
aft..........................	33	33	33	33	33
Basic aircraft cg position, % MAC:					
forward......................	21.9	21.9	21.9	21.9	20.4
aft..........................	23.4	23.4	23.4	23.4	22.4
Distance of the center of gravity of basic aircraft from frame No. 5, m:					
minimum......................	0.550	0.550	0.550	0.550	0.513
maximum......................	0.585	0.585	0.585	0.585	0.558

Figure 8 shows the position of the basic aircraft center of gravity, the length of the mean aerodynamic chord of the biplane wing cell (MAC) and its position relative to the datum line.

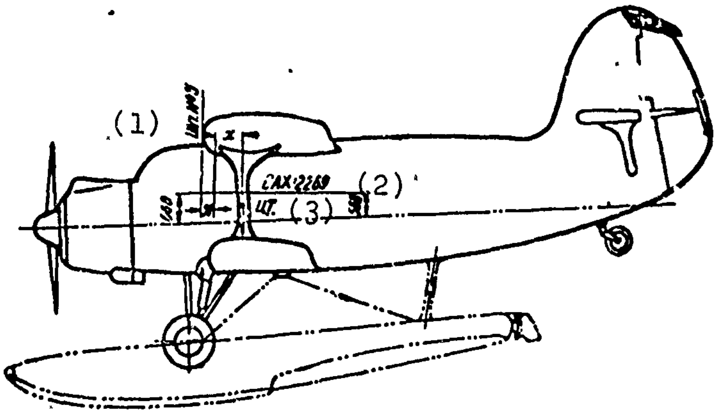

Fig. 8. Mean aerodynamic chord of the wing cell of the aircraft.

KEY: (1) Frame; (2) MAC; (3) cg.

The position of the center of gravity of the loaded aircraft should be checked by the method of moments or by cg position charts. An example of the use of the method of moments for determining the center of gravity of the aircraft, when it returns to base empty with minimum supply of fuel and oil in the tanks, is shown in Table 7.

Table 7.

Designation of load	Weight G, kg	Arm X, m	Moment GX, kg-m
Basic aircraft	3367	0,513	1730
Crew 2........	180	—0,336	—60
Fuel..........	50	0,944	47
Oil...........	25	—1,586	—40

Table 7 contains the load weights, including the weight of the aircraft, distance of the center of gravity of each load from frame No. 5 and the moments, computed by multiplication of the weights by the distance to frame No. 5. The arm is considered positive for loads located behind frame No. 5, and negative for loads located forward of frame No. 5. The arm of the center of gravity of the empty aircraft is taken from Table 7.

After the summation of weights and moments there is determined the distance of the center of gravity of the aircraft from frame No. 5 by formula

$$X_{cg} = \frac{\Sigma GX}{\Sigma G}, \tag{1}$$

and cg position in percent of MAC by formula

$$X_{MAC} = \frac{X_{cg} - L}{b_{MAC}} 100\% \text{ MAC}, \tag{2}$$

where L - distance from the beginning of MAC to frame No. 5, equal to 0.05 m; b_{MAC} - length of the MAC, equal to 2.269 m.

Using formulas (1) and (2) we obtain

$$X_{cg} = \frac{1677}{3622} = 0{,}46\ м;$$

$$X_{MAC} = \frac{0{,}46-0{,}05}{2{,}269}\,100 = 18{,}1\%\ \text{MAC}.$$

The examined case corresponds to the forward cg position of the aircraft. In this instance there is the case when the empty aircraft has cg position 20.4% MAC, i.e., the most forward possible for the given series.

Change of the plant layout or configuration, performed by the operating subunits, can considerably change the cg position. Table 8 contains the calculation of cg position for the case when the box with flight instrument weighing 42 kg has been removed from the aircraft.

$$\sum G = 3580\ \text{kg};$$

$$\sum GX = 1385\ \text{kg-m}.$$

As can be seen from Table 8, the arm of the box with flight instrument relative to frame No. 5 is equal to 6.97 m;

$$X_{cg} = \frac{1385}{3580} = 0{,}386\ м;$$

$$X_{MAC} = \frac{0{,}386-0{,}050}{2{,}269}\,100 = 14{,}8\%\ \text{MAC}.$$

As we see, the cg position far exceeded the limits of allowable forward cg position 17.2% MAC.

In this case it is necessary for the crew to remember the appropriate warning from the An-2 aircraft flight operations handling manual (p. 32), where it is stated that "If with respect to flight conditions there is no load aboard (ferrying, training, etc.) and landing is possible with small amount of fuel (150 to 300 kg), then it is necessary to create a cg position more to the aft."

The operational cg position can be obtained in such cases by the appropriate location of ground and other equipment, usually loaded into the aircraft. When ferrying it is necessary to remember that in the weight and cg position of the empty aircraft, indicated in the forms, there has been taken into account the flight instrument (42 kg) located at frames Nos. 21 and 22. On An-2T aircraft of PNR production (from No. 1G480[illegible] the box with the flight instrument is located at frames Nos. 14 and 15, on An2TP there is no flight instrument.

When ferrying the cg position is computed [illegible] the chart. The check of the cg position of the loaded aircraft and its weight is performed before its release for flight taking into account the placement of all loads: the passengers, luggage, cargo, etc. The position of the center of gravity of the aircraft with load is determined by cg position charts.

Before departure the aircraft commander by means of personal inspection is obliged to check that cargo is absent in the fuselage rear section and the door, leading there, is closed and locked.

Before departure the crew should brief the passengers, so that they would not move in the compartment, they would fasten their seat belts before takeoff and landing and that they would not touch the lines, wiring, and the shielded conductors of radio equipment. In horizontal flight the movement of one passenger to the toilet is permitted (with knowledge of the crew).

Capacities of systems

The right group of fuel tanks, *l*....................	620 ± 24
The left group of fuel tanks, *l*.....................	620 ± 24
Total capacity of fuel system, *l*..................	1240 ± 48
Normal refueling of the system, *l*..................	1200

Capacity of oil tank on aircraft since the 15 series, *l*	125
Normal servicing of tank with oil, *l*	80
Capacity of the compressed-air bottles, *l*	8
Capacity of the fire-fighting bottle, *l*	2.5

Operating data

Fuel consumption for 1 h of flight with respect to types of operations, kg:	
transporting	118
training	115
aircraft chemical operations	125
aerial survey	125
under mountain conditions	140
Fuel consumption for 1 h of engine operation on the ground, kg	45
Oil consumption for combustion in % of the fuel consumption	4
Fluid for shock struts of landing gear and tail unit	Oil AMG-10
Quantity of fluid, cm^3:	
in shock struts of landing gear	3360
in shock strut of tail wheel	440
Air pressure in shock struts with free shock absorbers under summer and winter conditions, kgf/cm^2:	
in shock struts of landing gear	30_{-1}
in shock strut of tail unit	25 ± 1
Settling of shock strut of landing gear, mm:	
for gross weight G = 4800 kg	135
" " " G = 5000 kg	144
" " " G = 5250 kg	148
" " " G = 5500 kg	170
Settling of shock strut of tail wheel, mm	60
Pressure in the air system bottle, kgf/cm^2	50
Pressure in the braking system, kgf/cm^2:	
wheels	6-8
skis	8-10
Air pressure in pneumatic tires, kgf/cm^2	3
Compression of pneumatic tires, mm:	
landing gear	60
tail unit	30-35
Pressure in fire-fighting system tank, kgf/cm^2	150

§ 5. FLIGHT CHARACTERISTICS AND SPECIFICATIONS

Flight characteristics and specifications are provided for aircraft with normal gross weight 5250 kg. The operation of An-2 aircraft with normal and landing gross weight 5250 kg and maximum takeoff weight 5500 kg is permitted from aircraft of series 64-01 and further, and also for earlier manufactured aircraft, for which there is installed a reinforced landing gear and the zone of installation of the attachment shoes of the rear landing gear struts to the fuselage is reinforced.

Takeoff and landing characteristics

Takeoff at nominal engine power rating:	
a) without the application of flaps:	
unstick speed, km/h	110
takeoff run, m	260
takeoff distance (up to altitude 25 m), m	800
b) with flaps deflected 30°:	
unstick speed, km/h	80
takeoff run, m	200
takeoff distance (up to altitude 25 m), m	600
Takeoff at maximum (takeoff) engine power rating:	
a) without the application of flaps:	
unstick speed, km/h	100
takeoff run, m	210
b) with flaps deflected 30°:	
unstick speed, km/h	70
takeoff run, m	170
takeoff distance (up to altitude 25 m), m	540
Landing:	
a) without the application of flaps:	
landing speed, km/h	110
landing run with braking, m	430
b) with deflection of flaps 30°:	
landing speed, km/h	87 ± 3
landing run with braking, m	225
c) with flaps deflected 40°:	
landing speed, km/h	82 ± 2
landing run with braking, m	215

Note. Takeoff and landing data are provided for standard conditions and for calm.

Basic flight characteristics of the aircraft

Maximum horizontal flight speed (in the transport version), km/h:	
near the ground	239-5
at critical altitude	256-5
Vertical velocity during climb near the ground at nominal engine power rating, m/s:	
in transport version	3.1
in agricultural version	1.2-2
Indicated cruising speed (when $p_{\text{н}}$ = 720 mm Hg; n = = 1700 r/min, H_{CT} = 800 m), km/h:	
transport version	190
agricultural version with sprayer	155
agricultural version with duster	160
The range of indicated cruising speeds of the aircraft in horizontal flight, km/h	147-210
Service ceiling of aircraft with gross weight 5250 kg, m	4500
The rate of descent of the aircraft, km/h:	
in still air	220
in turbulence	190
Rate of descent in a flight with passengers, m/s	2
Flying range of the aircraft with full fuel load under engine operating conditions corresponding to maximum range ($p_{\text{н}}$ = 540-625 mm Hg; n = = 1400 r/min), km	up to 2000

Flight restrictions

Maximum allowable glide speed (with respect to strength conditions), km/h	not over 300
Maximum allowable bank:	
in transport version, in zone	not over 45°
in agricultural version	not over 30°
Maximum flap depression:	
for takeoff and landing with wind up to 10 m/s.	30°
for takeoff and landing with wind from 10 to 18 m/s	20°

Note: 1. During cross wind perform takeoff and landing with flaps up.

2. In exceptional cases (forced landing and so forth) on landing it is permitted to extend flaps to 40°.

Maximum allowable wind velocity, m/s:	
for taxiing, takeoff and landing	18
cross wind for takeoff and landing at 90° angle to the landing pattern	6

Note. Perform taxiing with wind above 12 m/s at 60-90° angle to the longitudinal axis of the aircraft with escorts.

Maximum allowable firmness of soil:	
measured by striker [NIAI] (НИАИ)*, kgf/cm^2	3
determined from depth of track left when taxiing the aircraft, cm	not over 6-7
Maximum depth of unsmoothed snow cover (freshly fallen or old dry loose snow) for takeoff on wheel-type landing gear, cm	not over 35
Maximum depth of old, compacted or slightly smoothed snow cover for takeoff on wheel-type landing gear, cm	not over 25
Maximum permissible number of passengers (limited from the conditions of preservation of permissible cg position), people	12
Maximum payload, kg	1500

Aircraft Service Life

By orders of the Minister of Civil Aviation of the USSR the following service lives have been established for An-2 aircraft, including aircraft of PNR production:

1) before the first repair and overhaul:

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*[Translator's note: Scientific Research Aviation Institute].

when using in cargo and passenger versions - 2000 flying hours;

when using in agricultural, training and water versions - 1500 flying hours;

2) amortization service life:

for aircraft of agricultural, training and water versions - 12,000 flying hours:

Note. Consider agricultural and training An-2 aircraft, having run on aerial chemical operations or in training flights not less than 60% of the overhaul life established for these versions.

3) overall technical service life for transport and passenger An-2 aircraft - 15,000 flying hours.

Upon completion of repair in the aircraft forms there should be recorded: "For the aircraft there is established flying life: in cargo and passenger versions - 2000 h; in agricultural and training versions - 1500 h.

CHAPTER II

CONSTRUCTION OF THE AIRFRAME

The airframe of the aircraft consists of the fuselage, the wing cell and empennage.

For the simplicity of technology of production and repair and also for ease of transportation the airframe of the aircraft has been broken down into several separate parts (units), butt-jointed on bolted joints or suspended on hinges (slats, flaps, ailerons and controls). Connections, by which the airframe can be dismantled during transportation or repair, and the main units of the airframe are shown in the diagram of connections (Fig. 9).

The main parts of the airframe - fuselage, wings, stabilizer and fin - are made from D16T and D16AT duralumin of increased strength.

§ 6. FUSELAGE

The fuselage of the An-2 aircraft (Fig. 10) - semimonocoque, girder-stringer type, all-metal construction consists of frame and stressed skin.

The purpose of the fuselage is the foundation or the base of the aircraft. To the fuselage are fastened all units, in it are placed the equipment, crew and payload.

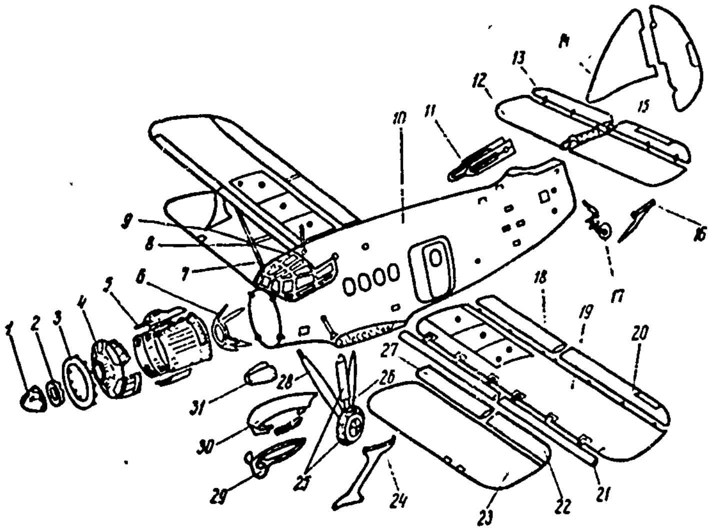

Fig. 9. Diagram of connections of units of the An-2 aircraft: 1 - propeller spinner; 2 - crankcase cowling; 3 - front wing of cowling; 4 - inner cowling; 5 - external cowling; 6 - engine mount; 7 - front load-carrying wire strips; 8 - strip holder "tipcat"; 9 - supporting wire strips; 10 - fuselage; 11 - empennage fillet; 12 - stabilizer; 13 - elevator; 14 - fin; 15 - rudder; 16 - stabilizer strut; 17 - tail wheel; 18 - upper wing flap; 19 - detachable part of upper wing; 20 - aileron; 21 - slat; 22 - tip flap of lower wing; 23 - detachable part of lower wing; 24 - strut of biplane wing cell; 25 - shock strut of landing gear with wheel; 26 - aft landing gear strut; 27 - root flap of lower wing; 28 - forward landing gear strut; 29 - fairing of the joint of center section with the lower wing; 30 - upper wing fairing; 31 - oil cooler duct.

The fuselage construction during manufacture ensures its technological breakdown into three main sections, which makes it possible to assemble the sections in separate independent accommodations (assembly jigs).

In the forward section of the fuselage between frames Nos. 1 and 5 there is placed the cockpit. Between frames Nos. 5 and 15 there is located the passenger or cargo compartment and behind frame No. 15 - the tail section. The tail section is not designed for the transportation of cargo and serves as an auxiliary compartment.

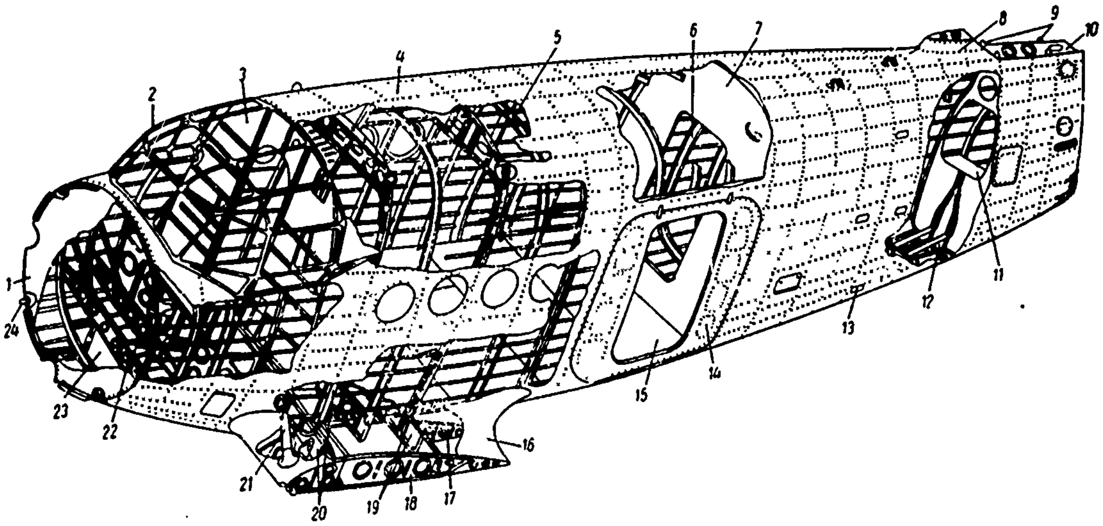

Fig. 10. Fuselage: 1 - frame No. 1; 2 - canopy frame; 3 - frame No. 5; 4 - skin; 5 - standard middle frame; 6 - standard tail frame; 7 - frame No. 15; 8 - fin unit; 9 - stabilizer mounting lugs; 10 - upper rib; 11 - storage battery panel; 12 - stiffening girders of tail wheel; 13 - step; 14 - door of cargo section with cutout under the passenger door; 15 - floor panels of the cargo section; 16 - wing center section; 17 - rib No. 1; 18 - rib No. 2; 19 - attachment frame No. 8 and wing center section aft spar; 20 - attachment frame No. 6 and wing center section front spar; 21 - wing center section pyramid; 22 - standard forward frame; 23 - bottom hatch (open); 24 - attachment point of engine mount.

Fuselage Frame

The fuselage frame (Fig. 11) consists of the lateral and longitudinal assemblies, the floor framework of the fuselage compartments, stiffeners of the tail unit and the fin, and also the edging of the cargo compartment door.

Lateral Assembly

The lateral assembly of the fuselage consists of 26 frames, the bows of the instrument panel and the reinforcement frames of the cutout under the door of the cargo section.

The frames are divided into two groups: main and standard. The main or attachment frames are frames Nos. 1, 4, 5, 6, 8, 23, 25, and 26. The main frames bear mounting lugs of the detachable parts of the aircraft and are subject to large concentrated loads, which they transfer to the thin-walled fuselage without overloading its separate elements. The main frames are made from an assembly of pressed profiles, sheets and walls.

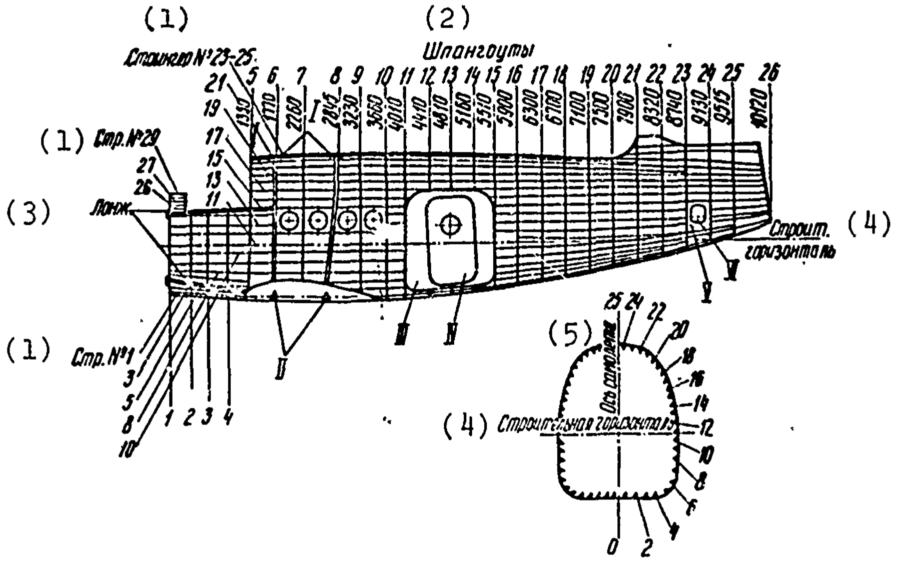
(1)
(2)
Шпангоуты
Стрингеры №23-25
(1) Стр.№29
27
26
(3) Лонж.
21
19
17
15
13
11
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
1330
1770
2260
2845
3230
3660
4010
4410
4810
5160
5510
5900
6300
6700
7100
7500
7900
8320
8740
9130
9515
10120
I
Строит. (4)
горизонталь
V
VI
(1) Стр.№1
3
5
8
10
1 2 3 4
II
III
IV
(5)
Ось самолета
25 24 22 20 18 16 14 12 10 8 6 4 2 0
(4) Строительная горизонталь

Fig. 11. .Diagram of the location of stringers and fuselage frames: I - mounting lugs of the upper detachable wing section; II - mounting lugs of the lower detachable wing section; III - cargo door; IV- passenger door; V - hatch for installation of tail wheel; VI - storage battery hatch.

KEY: (1) Stringer; (2) Frames; (3) Long.; (4) Datum line; (5) Axis of aircraft.

Frame No. 1 has circular shape with crescent-shaped concavities to the right under the exhaust pipe and underneath the oil cooler. The contour of the frame is made from pressed angle profile, to which is fastened a wall from sheet 0.8 mm thick. The wall of the frame, reinforced by pressed and rolled profiles, is simultaneously a fire wall with hermetically sealed cutouts under the engine control rods. Above on the frame are mounted brackets for attachment of the oil tank and on the right - mounting lugs of the exhaust pipe. In the middle part of the frame are mounted actuating arm control brackets of the engine and cowl flaps and below - bracket (frame) for attachment of the oil cooler.

On frame No. 1 are mounted four steel attachment lugs (Fig. 12) for the engine mount to the fuselage. Each lug with its tail piece is installed in a longeron and riveted to it by steel and duralumin rivets. The lug is fastened to the skin and frame with external duralumin cover plates and an inner knee plate.

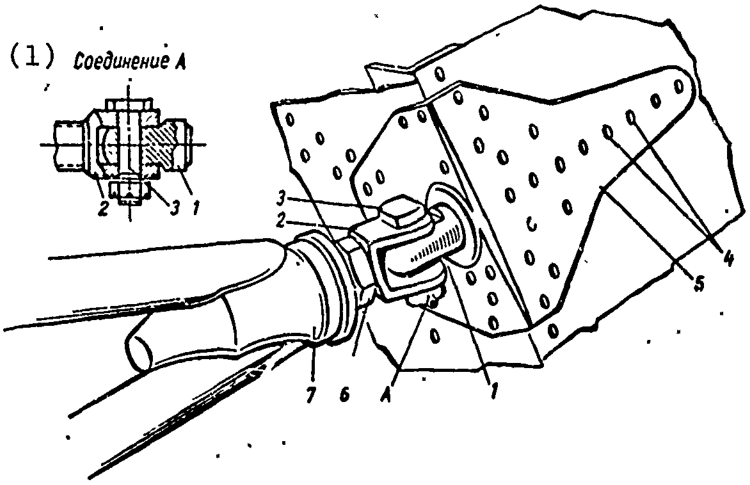

Fig. 12. Engine mount attachment lug to the fuselage: 1 - attachment lug of the engine mount to the fuselage; 2 - forked bolt; 3 - clamp bolt; 4 - rivets; 5 - duralumin plate; 6 - lock nut; 7 - jacket of engine mount.

KEY: (1) Joint A.

During operation (mainly after the expiration of the guaranteed service life of the aircraft) in the attachment lugs of the engine mount to the fuselage there were cases of the appearance of cracks.

For the purpose of preventing the failure of the engine mount attachment lugs to the fuselage on aircraft up to 57 series, on which lugs - part Sh0106-3 have not been replaced by new improved lugs - part Sh0106-13, it is necessary after every 100 hours of aircraft flight with the aid of a portable lamp and mirror to thoroughly inspect the lugs. The bottom lugs are checked through the bottom hatch located in the forward section of the fuselage, the upper - on the side of the cockpit.

The mount lugs must be inspected also regardless of the flying time with detection and elimination of vibration of the propeller or engine on the aircraft and in emergency cases (for instance, with tilting of the aircraft on the nose).

If cracks are detected on the lug, it should be replaced with the new improved lug Sh0106-13, being installed by the plant on aircraft from the 57 series.

During operation of the aircraft it is necessary to focus attention to the state of the attachment rivets of the lug to the fuselage. The weakening of forward rivets 4 (see Fig. 12) can be an external sign of cracks of the lug in the eye.

After every 300 h of aircraft flight and with engine change it is also necessary to thoroughly inspect the lugs with a mirror and portable lamp.

Frame No. 4 is a partial frame. The contour of the frame is riveted from two pressed angle sections.

In the bottom part of the frame to the contour with knees and inclined pressed corners there is riveted a T-beam and a wall 1 mm thick with round flanged openings for lightening. The wall is riveted to channel struts. The side walls of the frame lead to the cockpit canopy and are attached to the upper fuselage longerons. Underneath on the frame is attached an internal lug made from alloy AK6 for attachment of the steel shoe of the forward landing gear struts. The shoe is fastened to frame No. 4 by eight bolts 8.2 mm in diameter.

On frame No. 4 is mounted the fire-fighting bottle.

Frame No. 5 separates the cockpit from the passenger or cargo compartment. To the angle-section frame contour there is attached a wall 0.8 mm thick, reinforced by sections. The frame contour in the upper part along stringer No. 15 has a cut for passage of the upper fuselage longerons. In the wall of the frame there is installed the access door to the cockpit. The opening for the door is edged with pressed channel sections, on which are attached the brackets of the guides of the pilots' seats. In the upper part to the frame is fastened the cockpit canopy frame, in the middle part - two channel beams of the cockpit floor.

The lower part of the frame is a riveted T-beam, to which on two sides by bolts there are fastened the top and bottom lugs of the struts of the wing center section truss. To the wing center section truss in turn there is attached the shock strut of the landing gear and the forward load-carrying strips of the wing cell.

On the frame are mounted the components of the special equipment of the aircraft, the intermediate shaft bearing for manual starting of the engine and on the left - brackets with aircraft control rollers. Under the access door to the cockpit there is installed a cock for switching on passenger compartment heat.

During operation on the upper joint of frame No. 5, at the point of attachment of the inclined strut of the wing center section truss, cracks were observed, especially during operation on ski landing gear. For inspection of this joint it is necessary to remove the fairing. During repair at stringer No. 10 there is also revealed deformation of the side sections of frame No. 5. This deformation appears from shock loads during rough landing of the aircraft. The state of the lower joint of frame No. 5 and its connection with longitudinal cruciform detachable rod are inspected through the inspection hole in the bottom part of the fairing of the wing center section.

Frames No. 6 (Fig. 13) and No. 8 in their construction are similar to each other and serve for attachment of the aircraft wings. In the top part on the frames with bolts there are mounted the attachment joints of the detachable parts of the upper wing. In the bottom part the frames evolve into the wing center section spars, on which are mounted the attachment lugs of the detachable parts of the lower wing.

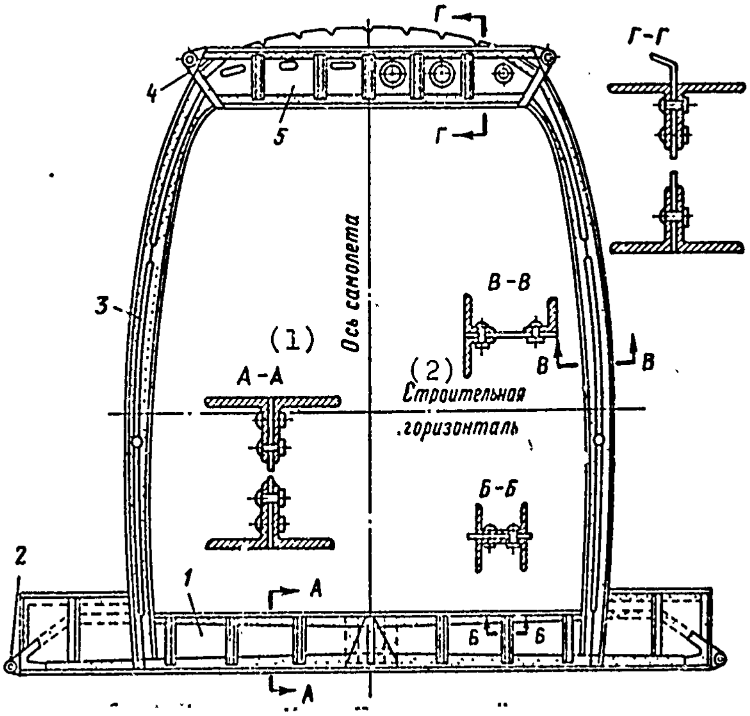

Fig. 13. Attachment frame No. 6: 1 - bottom part of frame (forward spar of wing center section); 2 - lower wing mounting lug; 3 - side wall of frame; 4 - upper wing mounting lug; 5 - top part of frame.

KEY: (1) Axis of aircraft; (2) Datum line.

The upper part of the frame has I-shaped section, which consists of pressed angles and a plate, reinforced with struts. In the walls of the plate there are openings for the passage of rods and control cables of the aircraft. On the wall of frame No. 6 there is installed a double-arm aileron control actuating device. On the wall of frame No. 8 are mounted UZ-1AM electrical mechanism for control of upper flaps and a bracket with elevator and rudder pulleys. For the greatest rigidity a duralumin brace strut has been installed between the upper parts of frames Nos. 6 and 8.

The sidewall of frame No. 6 consists of a plate 2 mm thick and pressed angles with milled flanges attached to it. The side wall of frame No. 8 is made from channel sheet 3 mm thick and is bent at a 6° angle. Frame No. 8 is placed on the side of the fuselage at small inclination as a result of the difference in the lengths of the geometrical chords of the upper and lower wing.

The lower part of the frames is a riveted I-beam, which consists of a plate and pressed angles. In the middle of the bottom part of frame No. 6 there is attached an inner joint from AK6 alloy for attaching the shoe of the rear landing gear struts.

Under the side walls of the frame there are steel seats under the lifts of the aircraft.

On the bottom part of frame No. 8 there is mounted a UZ-1AM electrical mechanism for control of lower flaps.

On aircraft in the agricultural version there sometimes appear cracks in the lower flange of frame No. 8 under the right mounting lug of the tank of chemicals. These cracks spread radially relative to the axis of opening of the attachment of the lug on the frame. A frame with such cracks must be repaired in repair concerns.

Frames Nos. 23 and 25 (Fig. 14) in the upper part will carry the front and rear stabilizer mounting lugs, respectively. The lugs are made from Chromansil plates 1.5 and 2 mm thick welded together and heat treated to $\sigma_{вр} = 110 \pm 10$ kgf/mm^2. The lugs are attached on frames with steel and duralumin rivets.

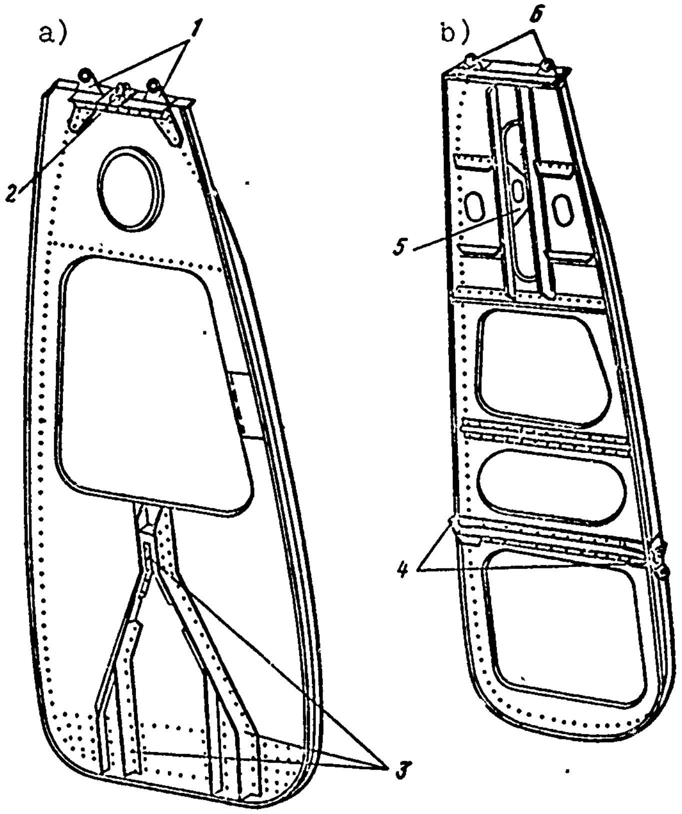

Fig. 14. Attachment frames No. 23 (a) and No. 25 (b): 1 - front mounting lugs of the stabilizer; 2 - mounting lug of the stabilizer brace strut; 3 - stiffeners of the tail wheel installation; 4 - mounting lugs of stabilizer struts and mooring clamps; 5 - actuating arm bracket of elevator control; 6 - rear mounting lugs of the stabilizer.

On frame No. 23 at the top is mounted the attachment lug of the stabilizer brace strut.

Both frames have contours of pressed sections and flanged walls 1.5 mm thick with flanged cutouts for lightening are attached to them.

In the bottom part of frame No. 23 there are three joints for attachment of the truss and the shock strut of the tail wheel.

On the side walls of frame No. 25 through the skin on bolts there are mounted the attachment lugs of the stabilizer struts with the mooring clamps of the aircraft.

The mounting lugs for installation of the tail wheel on frame No. 23 and the stabilizer struts on frame No. 25 are made from steel 45 and are not heat treated.

In the upper part of frame No. 25 there is mounted a bracket for attaching the three-arm elevator control actuating device and in the middle of the frame - two brackets for attaching the rudder pulleys.

Frame No. 26 is the closing frame of the fuselage and consists of a contour curved section 1.5 mm thick, to which is attached a flanged wall 1.2 mm thick with circular openings for lightening. On the frame is installed a bracket made from AK6 alloy with radial-thrust ball bearing mounted in it for attachment of the rudder.

Underneath on frame No. 26 there is mounted a steel seat under the lift of the aircraft.

Standard Z-shaped frames, stamped from D16AT material 1 mm thick and assembled from several sections, are joined by special cover plates. Sections under the stringers have standard slots with the cutout skirting. The frames do not receive the concentrated load and serve for support of stringers and skin.

Figure 15 shows standard frames Nos. 3, 12 and 19 of the front, middle and rear fuselage. The side walls of frames No. 2 and 3 lead to the cockpit canopy and are attached on the upper longerons. To the side walls of frames with knees and sloping pressed angles there are attached T-beams, serving as support of the cockpit floor. The beam consists of a vertical wall with flanged openings for lightening and an assembly of sections.

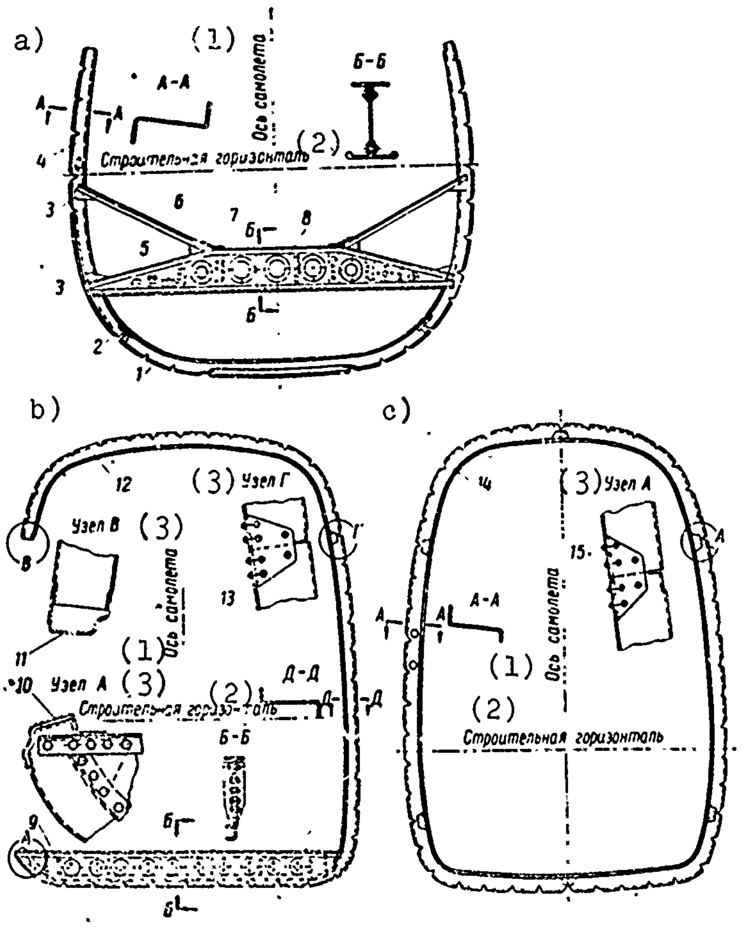
a)
(1)
Ось самолета
А-А
Б-Б
(2)
Строительная горизонталь
1
2
3
4
5
6
7
8
b)
12
(3) Узел Г
Узел В (3)
В
Г
Ось самолета
13
11
(1)
10
Узел А (3)
(2)
Д-Д
Строительная горизонталь
Б-Б
9
c)
14
(3) Узел А
15
А-А
(1)
Ось самолета
(2)
Строительная горизонталь

Fig. 15. Standard typical frames No. 3 (a), No. 12 (b) and No. 19 (c): 1 - bottom part of frame; 2 - connecting angle; 3 - connecting knees; 4 - section of frame; 5 - corner plate; 6 - pressed angle; 7 - attachment corner plate of the cockpit floor panel; 8 - frame beam; 9 - bottom part of frame; 10 - threshold of cargo compartment door; 11 - edging of cargo compartment door; 12 - section of frame; 13 - connecting plate; 14 - section of frame; 15 - connecting plate.

KEY: (1) Axis of aircraft; (2) Datum line; (3) Joint.

The side walls of middle frames Nos. 7, 9, 10, 11 of the fuselage form a Z-shaped closed contour, and the side walls of frames Nos. 12, 13 and 14 reach the edging of the cargo compartment door and are fastened on it. In the bottom part the middle frames have beams, which serve as support for the cargo compartment floor and are the lateral reinforcement assembly of the bottom part of the fuselage. The beams are assembled from a wall 1 mm thick and pressed angles. The wall has openings for lightening and skirting, with which it is fastened to the fuselage skin.

In the cutout zone under the cargo compartment door, between frames Nos. 11 and 15, on top and underneath there are installed additional Z-shaped frames of variable height 1 mm thick. The upper frames on one end finish on stringer No. 21, the lower - on stringer No. 3 and have standard slots under the intermediate stingers. The other end of the frame enters the door edging and is attached in it by rivets.

Frame No. 15 does not have a contour and consists of a solid flanged wall 0.8 mm thick, in which there is installed a double door for access to the tail compartment of the fuselage. On the left side of the upper part of the wall of the frame there is mounted a bracket with elevator and rudder control pulleys.

Tail frames from No. 16 to No. 21 have a closed contour and are made completely from Z-shaped sections. The left side wall of frame No. 16 is reinforced by angle section because of the cutout under the cargo door. On the upper part of frame No. 21 is mounted a bracket with elevator pulleys.

At a distance of 270 mm from frame No. 1 there is installed the instrument panel bow. The bow, made from L-shaped material 1.5 mm thick, ends on the upper longerons and is attached on them by angles.

Longitudinal Assembly

The longitudinal assembly consists of four longerons, 50 stringers, supporting bulb angles and rolled channel bars.

In the forward section of the fuselage between frames Nos. 1 and 6 in the upper part and between frames Nos. 1 and 5 in the bottom part in the direction of stringers Nos. 5 and 15 there are installed pressed channel sections Pr106-8 40 × 25 × 3 mm in size, being longerons. The upper longerons connect the side walls of frames Nos. 2, 3, and 4 and pass through the seats of frame

No. 5, on which they are fastened with the aid of a bracket made from AK6 alloy by rivets.

The bottom longerons at main frames Nos. 4 and 5 are cut and connected to them with the aid of milled shoes on bolts and rivets.

At frames Nos. 2 and 3 the longerons have a milled leg and they are fastened to it by angles with rivets.

The fuselage stringers, which consist of duralumin pressed sections Pr100-1 (12 × 12 × 1 mm angle), are arranged evenly along the generatrix of the fuselage and are inserted into standard slots of frames, having cutout skirting; sections are not cut at the intersection of standard frames. The stringer is fastened to the frame together with the skin by one rivet. With approach to main frames and main structural elements the stringers are cut, cut from under on them and are fastened to them together with the skin by rivets. In the stressed zones the stringers are connected to the main elements even by an additional knee. Between frames Nos. 4 and 6 stringers Nos. 1, 2, 3 and 8 are additionally supported by bulb angles.

By the same bulb angles there are supported stringers Nos. 0, 2, 4, 5, 6, 7, 9 and 11 of the rear fuselage between frames Nos. 15 and 21, and also stringers Nos. 4, 5 and 18 between frames Nos. 11 and 15 at the edging of the cargo compartment door. Bulb angles are also installed in the cutout zone under the cargo compartment door along stringers from No. 6 to 17 inclusively between frames Nos. 10, 11 and 15, 16. The supporting bulb angles are cut between the frames and are fastened with flanges to the main stringers by two rivets at the frames.

At the points of production joints, in the zone between frames Nos. 15 and 17, the stringers are connected with the aid of angle straps on rivets, made from the same section as the stringer. The strap is not fastened to the skin.

Stringer No. 2 between frames Nos. 1 and 4 and stringer No. 11 between frames Nos. 1 and 5, to which are fastened edgings of the bottom hatch, and the cockpit floor are made from pressed bulb angle.

In the forward section of the fuselage between frames No. 1 and instrument panel bow there are installed stringers No. 26 to No. 30 inclusively of channel section.

Upper stringers No. 24 between frames Nos. 7 and 15 are supported by L-shaped sections and are fastened to the vertical flange of stringers and to frames.

Cabin Floor Frame

Cockpit floor. The load-bearing elements of the cockpit floor are two stringers, arranged along the axis of the aircraft between frames Nos. 1 and 5. On the stringers are installed the hand and foot aircraft controls. The stringers are duralumin, of equal strength, L-shaped 2 mm thick. The width of the stringer is 210 mm, height in the middle 75 mm and on ends - 40 mm. The stringer is protected underneath by a plate 0.6 mm thick. The ends of the stringer with knees are attached to the sections of frames Nos. 1 and 5. The upper plane of the stringer together with the plates forms the floor of the cockpit, divided into two parts by a passage.

The horizontal panel of the passage is located along the threshold of frame No. 5 and underneath has a rigid stamped frame, riveted to a smooth plate. The panel is laid on beams of frames Nos. 2, 3 and 4 and attached to them, forming a step 360 mm high from the cargo compartment floor. For provision of convenient access to the units located under the floor, the middle part of the floor in the cockpit between frames Nos. 4 and 5 is made easily removable.

Along the passage with screws there is installed removable side panels, with removal of which there is provided convenient access from the cabin to the places where units are mounted, located under the floor. In front of the passage there is located an easily removable housing, covering the transverse tube of hand control of the aircraft.

For the unloading of stress of the upper longerons in the forward section of the cabin there is installed a stiffener, assembled from sheet 1.5 mm thick and sections. The stiffener is riveted to longerons and frame No. 1 and serves simultaneously as a panel for the installation of equipment.

Cargo compartment floor. The floor framework of the passenger or cargo compartment of the fuselage (Fig. 16) consists of longitudinal and transverse girders and serves for attaching the floor panels.

The transverse girders are the structural elements of frames of the middle part of the fuselage, which have been described above.

The longitudinal assembly of the floor consists of longitudinal girders, diaphragms and walls. Longitudinal girders are installed in seven rows at a distance of 250 mm between rows. The girders - channel section, are made from sheet 2 mm thick and are attached on the horizontal flange of the frame by two flush rivets. Between frames Nos. 5 and 7 sections are installed across.

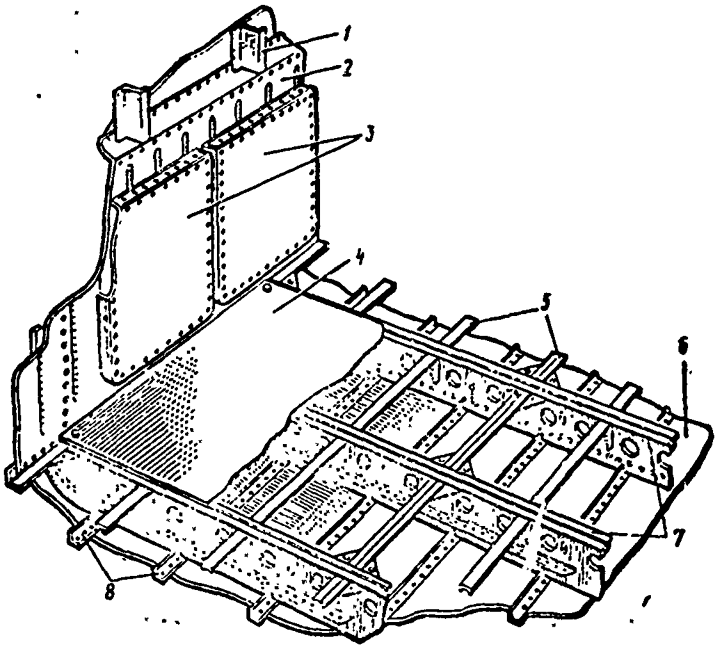

Fig. 16. The floor construction of the cargo compartment: 1 - frame; 2- side panel; 3 - collapsible rigid seats; 4 - floor panel; 5 - longitudinal girders of the floor; 6 - duralumin covering; 7 - frames (transverse girders of floor); 8 - stringer.

The diaphragms are arranged along the axis of the aircraft and at the sides. They consist of a wall 0.8 mm thick with skirtings and openings for lightening, riveted with pressed angles. The diaphragms are fastened to upright struts and horizontal flanges of the frame with the aid of knees on rivets. Part of the knees has stamped openings and springs under the screw fasteners, with which it is fastened to the framework of the floor panel. The diaphragms, located at the sides, are connected to the frames by additional plates. The plates have skirting, to which the inner skin is fastened by screws.

The walls are arranged along the axis of the aircraft between frames Nos. 5 and 7 and at the sides of the fuselage between frames Nos. 8 and 9. The walls are made from sheet 1 mm thick reinforced by pressed sections, and are fastened by its bottom skirting to the fuselage skin. In the side walls there are openings for the passage of flap control rods.

The flooring consists of individual panels, which lie on the framework, and each of them is fastened to it with the aid of four retaining springs. The panel consists of a sheet of plywood 4 mm thick, covered on both sides with duralumin sheets 0.5 mm thick. Duralumin sheets are glued to the plywood with BF-2 bakelite glue and attached along the contour by rivets. The outside of the panel is covered with cork crumb on nitrocellulose adhesive AK-20 for preventing slipping of the feet during movement through the compartment.

The construction of the floor is designed for a load of 1000 kg/m^2. Between frames Nos. 8 and 9 there is a hatch for access from the compartment to the UZ-1AM electrical mechanism for control of the lower flaps, which is covered with a panel, and between frames Nos. 7 and 8 on the left floor panel there is a round opening for the installation of a tank of chemicals when performing agricultural operations. In the transport version of the aircraft this opening is covered with a cover by six wood screws.

For the fastening of cargo on each side of the fuselage there are installed 9 tiedown clamps (5 below and 4 above the passenger seats) and 13 steel tiedown rings, which are screwed into the sockets riveted into the elements of the floor framework. The side clamps are made from AL4 alloy and are attached by bolts and rivets on the fuselage frames.

The steel tiedowns are an eye bolt with threads and a ring. On aircraft from the 60 series the number of tiedown rings is increased by four. The additional rings are installed at frames Nos. 12 and 13. The removed tiedown rings are stored in a special box, cut into the floor panel at frame No. 15, and their sockets are closed with plugs.

For tying down the loads to the aircraft there are applied nine tiedown ropes and a net. On the right side of the fuselage inside the cargo compartment there are placed marks and inscriptions for the location of loads.

Along the aft section there is installed a floor, which consists of individual panels, lain on П-shaped sections. The panels are similar to the panels of the cargo compartment and are fastened to the fuselage sections with retaining springs.

The flooring of the aft compartment between frames Nos. 16 and 22 is replaced by a light treadway, covered with cork crumb. The panels are fastened to the frames with bolts and anchor nuts.

Tail Wheel Stiffeners

For supporting the joints of the tail installation of the wheels between frames Nos. 22 and 24 to the skin and frames of the fuselage there are attached beams and a horizontal panel.

The beams are located in the bottom part of the fuselage between frames Nos. 22 and 23 and consist of a П-shaped section, two diaphragms and a cover plate riveted together. The П-shaped section is attached to the fuselage skin and passes into the seat of frame No. 22, in which it is fastened with the aid of knees. The diaphragms are attached to pressed sections of frame No. 23 and are fastened to the wall by bolts together with the bottom mounting lugs of the tail wheel truss.

The horizontal panel is located between frames Nos. 23 and 24 and consists of a sheet 1 mm thick, reinforced by pressed and bent sections. The panel is riveted to the walls of frames and to the fuselage skin and it serves simultaneously as an area, on which the aircraft storage battery container is installed.

During operation of the aircraft (up to the 44 series) there appeared cracks of the inclined stiffening brace strut between frames Nos. 22 and 23, and also cracks under the reinforced angle plates at the places of attachment of the tail wheel truss.

The cracks are easily revealed during inspection of the stiffeners and frame with the aid of a portable lamp on the rear fuselage.

On aircraft from the 156 series the rear fuselage is reinforced in the area of the mounting lugs of installation of the tail wheel by means of replacement of the section D16-TPr111-5 by section D16-TPr-111-34 on frame No. 23 and the horizontal platform of the storage battery, by change in the construction of the siffening.girders of the bottom mounting lugs of the tail wheel truss and by an increase in the diameter of bolts, fastening the tail wheel truss, from 6 to 8 mm.

Fin Stiffeners

The upper flanges of frames of the rear fuselage are connected by a horizontal rib, which together with an additional leading edge and front rim forms the stiffener, creating a smooth transfer to the fin.

The rib is cut in two by frames and consists of a stamped leading edge, two diaphragms with openings for lightening and contour pressed angles. At a distance of 140 mm above the main rib in its forward part there is installed an additional stamped leading edge, which has a break on frame No. 22 and is connected with the rib at frame No. 23 with the aid of two knees, forming the seat for the stabilizer.

At a distance of 170 mm above the upper rib there is installed a second rib, serving for support of the skin and creation of smoothness of outline. All the stiffeners of the fin, including the rim, are made from duralumin sheet 1 mm thick.

The Edging of the Cutout Under the Door of the Cargo Compartment

The edging of the cutout under the cargo compartment door is made from stamped duralumin shaped sections 1.5 mm thick. The edging is assembled from eight sections, connected by internal shaped inserts with flush rivets. To avoid abrasion of the lower section a stainless steel threshold has been installed.

Fuselage Skin

The fuselage skin (Fig. 17) is the main structural element and is manufactured from duralumin from 0.6 to 1.2 mm thick.

The skin of the aft part of the fuselage is basically made from sheets 0.6 mm thick, in the forward and middle part the thickness of sheets is 0.8 mm, and in the zone of maximum stresses (windows, cargo door and biplane cell) — 1-1.2 mm.

The sheets of the skin are joined overlapped, without skirting, along stringers and frames, where each forward sheet overlaps the rear, and each upper sheet overlaps the lower. The joints along the upper sheets are hermetically sealed by watertight seal. The chamfers are removed along the edges of the outer sheets.

The skin is attached to the fuselage framework by 866-A rivets made from D18 duralumin with mushroom head 2.6-3 mm in diameter.

Along cross joints the sheets overlap one another 35 mm and they are riveted with two rows of rivets, whereupon rivets, which rivet the sheets to the frame, 3 mm in diameter are used, and the rivets which fasten only sheets, - 2.6 mm in diameter.

Along stringers the joining of the sheets is accomplished by rivets 3 mm in diameter in one row. Rivets 3 mm in diameter are used to attach the skin along the pressed sections of joints of frames even and along all the main edgings of hatches; in all the remaining places of free riveting rivets 2.6 mm in diameter are used predominantly.

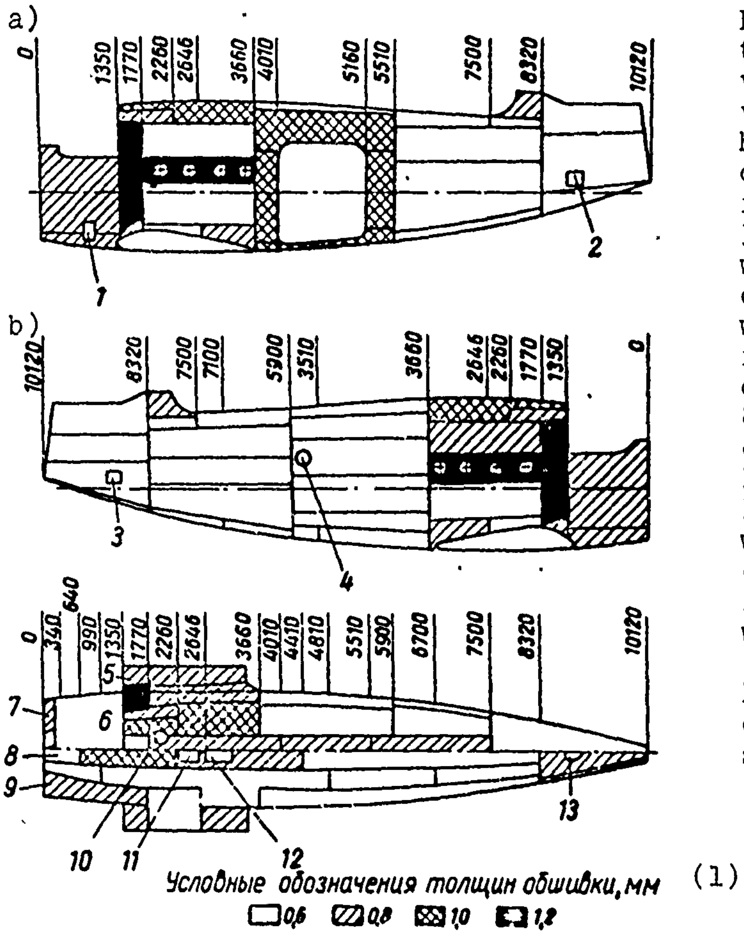
a)
0
1350
1770
2260
2646
3660
4010
5160
5510
7500
8320
10120
1
2
b)
10120
8320
7500
7100
5900
3510
3660
2646
2260
1770
1350
0
3
4
0
340
640
990
1350
1770
2260
2646
3660
4010
4410
4810
5510
5900
6700
7500
8320
10120
5
6
7
8
9
10
11
12
13
Условные обозначения толщин обшивки, мм (1)
0,6
0,8
1,0
1,2

Fig. 17. Diagram of the fuselage skin: a) view of left side; b) view of right side; 1 - hatch for access to fuel drain cock; 2 - cutout for battery container; 3 - cutout for tail wheel opening; 4 - cutout for window; 5 - wing center section fillet; 6 - cutout for canopy; 7 - top view; 8 - cutout for oil cooler; 9 - bottom view; 10 - cutout under hatch; 11 - cutout for framework of MRP-48; 12 - cutout for UZ-1A hatch; 13 - cutout for tail wheel.

KEY: (1) Conventional designations of the skin thickness, mm.

In the lower part of the fuselage skin there are drainage holes. During operation on the metal fuselage skin local deformations (waviness) were observed. With the appearance of deformation of the skin near the frames it is necessary to check the rivet seams. With light rapping by a hammer on the skin around the rivet seam the broken rivets pop out, and the weakened rivets vibrate. This defect appears as a result of the prolonged operation or the incorrect heat treatment of a rivet. The rivets having damage and weakening of fit must be replaced with new.

For the elimination of pops (waviness) on aircraft from the 100 series there has been introduced reinforcement of the lower fuselage skin between frames Nos. 8 and 9 by the installation of a diaphragm.

Fuselage Doors

On the left side of the fuselage between frames Nos. 11 and 15 there is located the cargo compartment door, suspended on the rigid edging on two steel stamped loops and being opened outside upward.

In the cargo compartment door there is installed a door for passengers, opening inside the fuselage. The door is hung on two steel stamped loops, installed inside on the frame of the cargo compartment door.

Both doors have rigid stamped frames and smooth outer skin. The frames are made from AMtsM material, the skin - from D16T 1 mm thick.

The frame of the cargo compartment door consists of two halves, connected at the top and bottom by shaped connection pieces with rivets. The bottom connection piece, serving as threshold, is covered with stainless steel.

The top connection piece extends under the door hinge and is supported by inner steel casings.

The cargo compartment door is held in the closed position by five locks, being locked from the cargo compartment. Four retaining springs are located on the right and left sides of the door and the fifth additional lever lock - below the door.

The cargo compartment door is held in the open position by the passenger door, which is used as a brace. The passenger door above has a special bracket, which ends with a ball, by which it is inserted into the seat on the side of the fuselage at frame No. 15 and is locked with a pin.

The passenger door has a window 320 mm in diameter and a lock with two handles. The inner lock handle in flight is locked with a shock cord. On the parking apron the door is locked by a key from the outside. The passenger door has electric signalling, which also serves as signalling for the cargo compartment door. A red lamp on the central panel in the cockpit with the battery turned on goes out only when both doors are closed. Both doors are sealed with a rubber tube.

In the bulkheads of frames Nos. 5 and 15 two inner doors are installed: front - into the cockpit and rear - into the rear compartment. Both doors are assembled from smooth sheets 0.6 mm thick and a light section frame.

The cockpit door is hung on two steel loops, has a round window 400 mm in diameter, has pressurization and a lock with a handle and key. The handle is installed only on the cockpit side. The lock is locked by a key from the cargo compartment. The rear door is double and provides passage into the rear compartment of the fuselage with the one left side open. Each side is hung on frame No. 15 on two loops. The right side can be opened only from the aft compartment side. The lock on the left side is fitted with two handles and its catch enters the groove of the second half. The right half has only one inner handle, on the axis of which there is a traverse with rods.

The rods go into the seats of frame No. 15 and hold the door in the closed position.

Operational Hatches.

For inspection and maintenance of units and elements of control and equipment of the aircraft operational hatches have been made in the fuselage skin. Large hatches with strong edging have retaining springs, which are opened with a screwdriver, standard inspection hatches are opened by finger pressure.

In the bottom part of the fuselage between frames Nos. 2 and 3 for access to units located under the cockpit floor, there is placed a hatch with a folding cover, which is opened by hand by bringing together the pins of the locking rods. With opening of the hatch the light which illuminates the space under the cockpit floor automatically lights up. On the left side of the fuselage between frames Nos. 3 and 4 there is a hole for draining fuel from the system. Underneath the fuselage between frames Nos. 8 and 9 there is a hatch for inspection of the UZ-1A mechanism for control of the lower flaps. In the rear fuselage on the left side between frames Nos. 23 and 24 there is a hatch for access to the battery and on the right side of the fuselage between these frames there is a hatch for inspection of the elements of the truss and shock absorber of the tail wheel installation. All the operational hatches have inscriptions with indication of their purpose.

In order to climb up to the fuselage, outside on the left side of the fuselage between frames Nos. 18, 19 and 20 there are four steps and two handles. For preventing slippage of the feet when walking on the upper skin of the fuselage there is a treadway from cork crumb, glued to the skin with nitrocellulose adhesive AK-20. For setting the aircraft in the line of flight when levelling on the sides of the fuselage there are fixed points: forward on frame No. 4 and aft on frame No.22.

Wing Center Section

The wing center section is the main structural element of the fuselage and consists of the framework and skin. The main elements of the longitudinal assembly of the wing center section are the lower beams of frames Nos. 6 and 8, serving simultaneously as forward and aft spars of the wing center section. Across the upper surface of the wing center section there are installed 16 stringers made from pressed bulb angle.

The lateral assembly of the wing center section consists of standard ribs, arranged in pairs on the right and left sides of the fuselage. Rib No. 1 is installed closer to the side of the fuselage at a distance of 960 mm from the axis of the aircraft, rib No. 2 - at a distance of 1300 mm. The ribs are cut by spars into three parts (nose, middle and the tailpiece) and are made from sheet with flanged walls, grooves and openings for lightening.

The middle of rib No. 2 perceives considerable forces from landing-gear loads, in its lower part has a flange made of pressed angle and wall thickness 1.2 mm. The rib flange is connected to the spars with the aid of milled shoes on bolts and rivets.

The tailpiece of rib No. 2 has two pressed angles, ending with a steel joint, serving as a rest for clamping the strip, closing the slot between the wing center section of the fuselage and the lower wing.

The skin of the wing center section is the main structural element and is manufactured from duralumin sheets 0.8 mm thick. The lower interspar sheet is made 1 mm thick. The skin is attached to the frame by rivets with mushroom heads and to the side of rib No. 2 - by 863A flush rivets with diameter 3.5 mm. On stringers there are fastened rivets 3 mm in diameter, on shoes - 5 mm, in the remaining places - 3.5 mm.

The transition points of the wing center section to the fuselage are made with the aid of a nonremoval fillet, which consists of five parts made from sheet 0.8 mm thick, the forward section - from sheet 1 mm thick. The fillets, also being the main elements of the wing center section, transfer to the fuselage the torsional and bending forces from the concentrated landing gear and lower wing forces.

At the left bottom part of the front covering at frame No. 6 there is located an inspection hole for access to the electrical equipment recepticle. For provision of access to the attachment points of the wing center section truss on frame No. 5 in the bottom part of the fillet of the wing center section there are inspection holes.

Wing Center Section Truss

In the wing center section there is a truss in the form of a pyramid (Fig. 18), to the joints of which are fastened the shock struts of the landing gear and the front load-carrying wire strips of the wing cell.

The truss consists of three Chromansil struts, heat treated to $\sigma_{\text{Bp}} = 120 \pm 10$ kgf/mm^2, which are hinged at the joints of frame No. 5 and on the front spar of the wing center section.

Such arrangement of the truss ensures its stability in all directions.

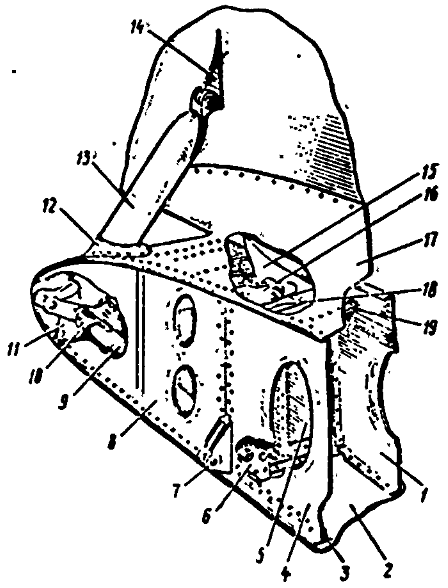

Fig. 18. Truss of wing center section: 1 - middle of rib No. 1; 2 - skin of wing center section part of the fuselage; 3 - angle bar of middle of rib No. 2; 4 - wall of the middle of rib No. 2; 5 - bottom part of frame No. 6 (front spar of wing center section); 6 - fitting; 7 - attachment point of lower wing; 8 - leading edge of rib No. 2; 9 - transverse tubular strut; 10 - forked bolt with lubricating screw; 11 - universal joint of attachment of the landing gear shock strut; 12 - fairing; 13 - front inclined strut; 14 - side joint of frame No. 5; 15 - bottom joint of frame No. 5; 16 - longitudinal removable (cruciform) rod; 17 - fillet; 18 - inspection hole from aircraft No. 134-01; 19 - stringer.

The main element of the truss is the front inclined strut, which consists of a drop-shaped Chromansil tube with wall thickness 2.5 mm and two forked joints welded to its ends.

The upper end of the strut is connected to the lateral joint of frame No. 5, and the lower - to the longitudinal stamped detachable rod with cruciform cross section and through a forked bolt - with transverse welded tubular strut.

The longitudinal cruciform removable rod with its other end is fastened to the bottom joint of frame No. 5, and the tubular strut - to the forked bolt installed on the forward attachment point of frame No. 6 of the lower removable wing section to the wing center section. Into the middle opening of the lower fork of the inclined strut there is inserted a forked bolt with a lubricating screw, serving as the axle of the universal joint of attachment of the landing gear shock strut. To the fork of the bolt is fastened a transverse tubular strut, and internal eyes of the inclined strut there is fastened a longitudinal cruciform rod. The external lugs of the strut serve for attachment of the mounting link of the wire strips.

For convenience of coupling of the truss of the wing center section to the fuselage on aircraft from the 67 series there have been introduced stepped attachment bolts of the wing center section truss to the fuselage. These bolts are interchangeable. For prevention of the appearance of cracks in the side strut in the area of welds and in the longitudinal cruciform removable rod at the lugs it is necessary after every 100 hours of flight to thoroughly check (with fairings removed) the condition of the lower lug of the front inclined strut, focusing special attention to welds, through the inspection hatches of the wing center section it is necessary to thoroughly inspect the connection of the longitudinal cruciform rod of the wing center section truss with the bottom lug on frame No. 5, to see that there are no cracks in the lugs of the removable rods and the joint.

During repair of the aircraft the struts and detachable rods of the wing center section truss undergo magnetic check. With the detection of cracks the struts and rods will be replaced.

Cockpit Canopy

The cockpit canopy consists of a steel tubular frame and plexiglas panels 3 mm thick fixed in it (see Fig. 10). For the mounting of panels in the frame there are threaded self-locking sleeves welded on ribs and soldered in tubes. The plexiglas panels edged with thiokol strip are placed in the ribs and are pressed to them with the aid of external duralumin cover plates by screws.

The sealing of the panels is accomplished by thiokol sealing putty.

On aircraft from the 52 series on the left front side of the canopy there are installed two TSBP-17 glasses with electrical heating, in connection with which there are installed the automatic device of AOS-81 glass and K-25A contactors, and also the installation of the AS-2 windshield wiper is changed. Heating with warm air on aircraft from the 52 series is supplied only to the copilot's windows.

On the two forward side glasses (right and left) there are installed electric windshield wipers. The windshield wiper switch is located on the left panel.

On aircraft of the 138-01 series for elimination of bowing of the right glass of the canopy and improvement of the operation of the windshield wiper the thickness of glass has been changed from 3 to 8 mm.

The two side and the right lower panels of the canopy move back along a milled h-shaped guide, made from duralumin plate. For movement and locking of the flaps a handle lock is installed on them, consisting of a housing, a pivot bolt with tooth and spring. In the top of the canopy there is located a 1050 × 1130 mm emergency hatch cover, easily jettisonable in flight. For locking and release of the hatch cover there is a mechanism in its front part which consists of three universal rods, packed in bearings. The rods have hooks welded on, with which they engage the brackets welded on the frame. At the rear end of the hatch cover there are located three welded stops, which enter the appropriate recesses on the frame.

For release of the cover it is sufficient to tug the handle located in the center of the middle universal rod, with this the hooks of the rods disengage from the brackets of the frame and the airflow, drawing off the cover, turns it around the back stops.

For improvement of the airtightness of the cockpit on aircraft from the 49 series the junction of the emergency hatch cover with the canopy is stuck with cloth tape.

The canopy is fastened to the skin of the forward section, longerons and frames Nos. 5 and 6 of the fuselage on welded eyelets and brackets with bolts.

Standard and Auxiliary Equipment of the Fuselage Compartments

The equipment placed in the cockpit, cargo compartment and tail section serves for the creation of conveniences for the crew and passengers enroute, and also for operating personnel during operation and the transportation of cargo.

Equipment of the Cockpit

In the cockpit are installed two easily removable seats (Fig. 19). The seats are installed at a 16° angle and can be moved in the vertical direction.

Each seat consists of a pan with back, locking mechanism and guides. The left seat is additionally equipped with a right elbow-rest.

The seat pan is made from duralumin sheets 1 mm thick edged with a pressed bulb section, and the frame from П-shaped sections.

At the rear to the side sections are fastened brackets with sleeves under guides. On the lower brackets, additionally connected to the wall, the locking mechanism is mounted. The height of the seat pan with back is 610 mm.

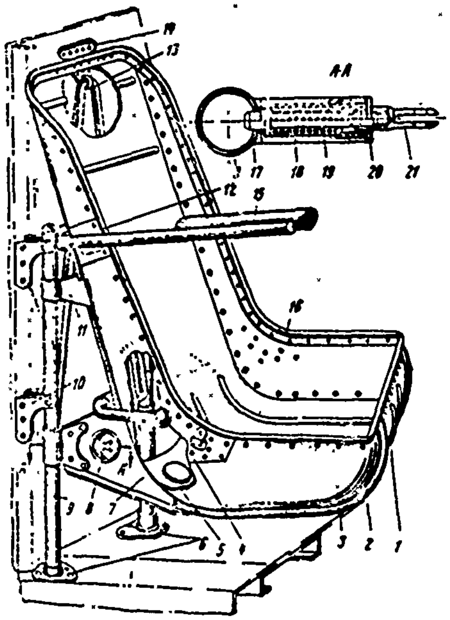

Fig. 19. Pilot's seat: 1 - wall of seat; 2 - seat contour; 3 - side wall; 4 - attachment bracket for seat belts; 5 - connecting knee; 6 - guide support; 7 - bottom bracket; 8 - locking mechanism handle; 9 - guide; 10 - guide attachment brackets; 11 - upper bracket; 12 - elbow-rest rack; 13 - shock cord; 14 - shock absorber hook; 15 - elbow-rest; 16 - edging section; 17 - locking mechanism pintle; 18 - cylinder of mechanism; 19 - spring of mechanism; 20 - guiding nut; 21 - fork.

The seat pan guides are made from Chromansil tube 25 × 22 mm in diameter, whose surface is chrome-plated and polished. In the guides there are openings under the pintles of the locking mechanism. The guides are attached with the aid of brackets on frame No. 5 and step bearings on the floor.

For raising the seat upward on the frame there is installed a shock cord, the bottom ends of which are fastened on the seat brackets. In order to raise the seat upward, it is necessary to pull the lever of the locking mechanism, with this the pintles leave the openings of the guides and make it possible for the shock absorber to raise the seat.

Lowering of the seat occurs in the same sequence, but it is necessary to press down on the seat, in order to overcome the tensile stress of the shock absorber. Movement of the seat is 140 mm.

The elbow-rest of the left seat is made from telescopically connected steel tubes, which permit stowing it behind the backrest. The elbow-rest can have two height adjusting positions, for which on the side wall of the seat pan there is a rack with two grooves. A tooth welded on the tube of the elbow-rest enters the grooves. The pilot's left hand rests on a box, covering the electrical wire bundles and installed on a longeron.

The back and seat cushions are made soft, easily removable. The elbow-rest, seat and back cushions are covered with leatherette. The seats have standard waist belts. As a support for the pilot's head at any position of the seat in height there serves the soft skin of frame No. 5, covered with leatherette.

The sides of the cabin have a decorative covering, which consists of plywood panels covered with leatherette and fastened with screws.

On the right side is located a flare pistol and a bandolier with 12 cartridges. The pistol is located in a holster, under which in the fuselage skin there is a through hole which allows shooting through the side of the fuselage, without taking the pistol from the holster.

The cockpit has ventilation with inflow of fresh air. On aircraft from the 35 series above the instrument panel there are installed two fans, which provide adjustment of the direction of the air stream, separate for each pilot. Additional cockpit ventilation is introduced with the cold air intake, installed on the left side of the fuselage, and by the exit of air through the cap installed on the cabin floor under the central panel.

Blowing of the space under the cockpit floor with air is accomplished with the aid of the front air intake with a tube installed on the left side of the fuselage. During the winter period of aircraft operation the air intake and tube are removed, and the opening is shut with a cover. On aircraft from the 60 series there is introduced additional air blowing of the space under the floor. The air intake is installed on the right side of the fuselage between frames Nos. 3 and 4, and the air stream is directed to the fire-fighting equipment bottle.

The top canopy panels are equipped with dark fabric blinds, protecting the crew from solar rays. The blinds easily move into the sides.

Equipment of the Cargo Compartment

On the sides of the compartment from the floor to stringer No. 10 there are installed side panels from duralumin sheets with grooves. The panels are fastened to frames and are attached to the sheets of the floor with screws. On top the panels are finished with cornice. The panels serve as protection of the fuselage skin from damages during loading and transportation of loads.

Between frames Nos. 6 and 8 the panel is extended upward to stringer No. 12 and is made in the form of a removable hatch cover, serving as protection of the lines of the fuel system from damage.

When using an aircraft in the ambulance version on the sides of the fuselage in the cabin there are installed steel brackets and straps for the attachment of six standard litters. On aircraft from the first machine of the 70 series there are installed cast brackets from magnesium alloy.

Cabin Ventilation

The cabin ventilation is suction and exhaust. The airflow enters the ceiling air intake, located at frame No. 15, and exits through the second ceiling air intake, located at frame No. 6. The smooth opening of air intakes is accomplished by means of screw adjustment. The ventilation air intakes are hermetically sealed. On aircraft from the 60 series ventilation has been improved by the introduction of an additional forcing intake at frames No. 15 along the upper skin and by increase in the size of the suction intake at frame No. 5.

For improvement of the ventilation of the passenger compartment on aircraft from the 172-01 series there is installed individual plenum ventilation (Fig. 20).

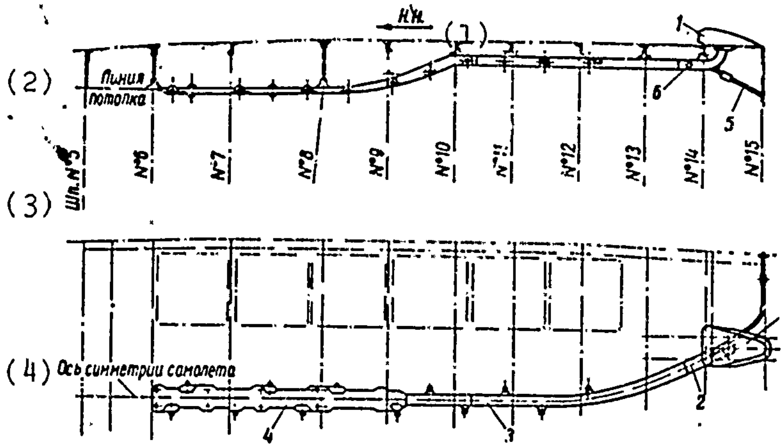

Fig. 20. Diagram of ventilation of the passenger compartment on aircraft of series 172-01: 1 - air intake; 2 - valve end; 3 - tube with individual fans; 4 - duct with individual fans; 5 - tube for water draining; 6 - valve.

KEY: (1) Direction of flight; (2) Ceiling line; (3) Frame; (4) Axis of symmetry of the aircraft.

The ventilation system includes; air intake, bend with valve, tube, duct and tube for water draining. The air intake is located on the fuselage on top between frames Nos. 14 and 15. Air from the intake enters the bend with valve and further under pressure enters the tube and duct with individual fans.

The tube and duct are made from aluminum alloy and go from frame No. 14 to frame No. 6 under the upper pipe of the fuselage. The duct is fastened at the ceiling line to frames No. 6, 8, 9, and the tube - to frames Nos. 10, 11, 12, 13 and 14.

Seats for Passengers and Auxiliary Equipment

Along the sides of the compartment are installed ten rigid folding seats for passengers: six - along the right side and four - along the left side of the fuselage. On aircraft from the 172 series the manufacturer installed 12 seats, six along each side of the fuselage.

At the places of installation of seats between the frames there have been furnished channel sections with anchor nuts, to which the eyelets of the seats are attached through the inner skin with screws.

The seat is a riveted construction and is made in the form of a stamped out duralumin pan edged with pressed angle. To the seat pan is hinged a bent duralumin bow (tube), serving as the support of the seat in the raised position. In the lowered position the bow is stowed in the pan with the aid of a spring, and the seat is held by a pintle, entering the bracket installed on the inside skin.

For preventing the automatic actuation of the seat retracting mechanism in bumpy air the clamping of seats has been provided. For this purpose on aircraft from the 171-01 series at the bottom of the bow there are installed latches, which enter between the clamp and spacer attached to the cargo compartment floor.

On aircraft from series 82-01 to series 170-20 the passenger seats were held in the open position with the aid of special clips, which had the shape of a channel, attached to the cargo floor.

Along the sides of the fuselage between stringers Nos. 16 and 15 and frames Nos. 7-12 on the right side and frames Nos. 6-10 on the left there are installed handrails for passengers in the form of duralumin tubes.

For the creation of comfort and the necessary conveniences for the passengers enroute at present the transport version of the An-2 aircraft, designed for transportation of passengers, is equipped with 12 passenger seats, installed prior to flight of the aircraft, of which five - along the right side of the aircraft and seven - on the left side, where the seats are installed in three rows with two in each row side by side, as shown in Fig. 7.

On some aircraft there are other configurations, where the seats are arranged in four rows, three seats to a row, or along the sides of the compartment at a 45° angle to the longitudinal axis of the aircraft (six seats on the left and seven - on the right side of the compartment).

Between frames Nos. 6 and 7 on the right side of the compartment there are installed two standard first-aid kits. On aircraft from the 35 series on all windows there are installed movable curtains of white tussore.

Along the cargo compartment between frames Nos. 8 and 15 there are stretched two static lines for parachutists.

On aircraft from the 37 series the right cable (before flight) is extended and at frame No. 7 there is installed a spring latch for removal and attachment of the cable in a position which provides free opening of the ceiling hatch.

For entry into the fuselage through the passenger door or through the cargo door there are detachable stairs with a scraper welded on for cleaning of footwear before entering the fuselage.

The stairs in flight should be mounted on the wall of frame No. 15.

The Heating System of the Fuselage Cabin and Canopy Glass

The heating system of the fuselage cabin and canopy glass (Fig. 21) consists of a cold air intake with heat exchanger on the exhaust pipe, a warm air distributor with heating system operation valve, passenger compartment heating valve, canopy glass heating valve, and lines. Cold air, entering the intake and heating in the heat exchanger around the exhaust pipe with ribs, enters the distributor. From the distributor warm air can be directed into the system or if necessary directed outside the aircraft. The line, discharging warm air outside the aircraft, is welded, and is made from AM alloy. The lines, supplying warm air from the distributor into the cockpit and to the canopy glass are made from AMgM alloy. The line supplying warm air from the distributor into the passenger compartment - welded, made from AMtsAM alloy. The lines and the distributor are heat-insulated with one layer of ASIM-3, 5 and are wound on the outside with glass cloth.

On aircraft up to the 37 series control of the distributor butterfly valves - cable, dual and is accomplished by two controls with double actuating arms, installed in the cockpit on the central panel next to the dust filter control.

The heating control valve of the canopy glass is located on the instrument panel under the headlight and navigation light [ANO] (AHO) cover.

The passenger compartment heat valve is located on frame No. 5 under the cockpit access door.

On aircraft from the 37 series the airplane heating and canopy glass system heating has been improved by increase in the

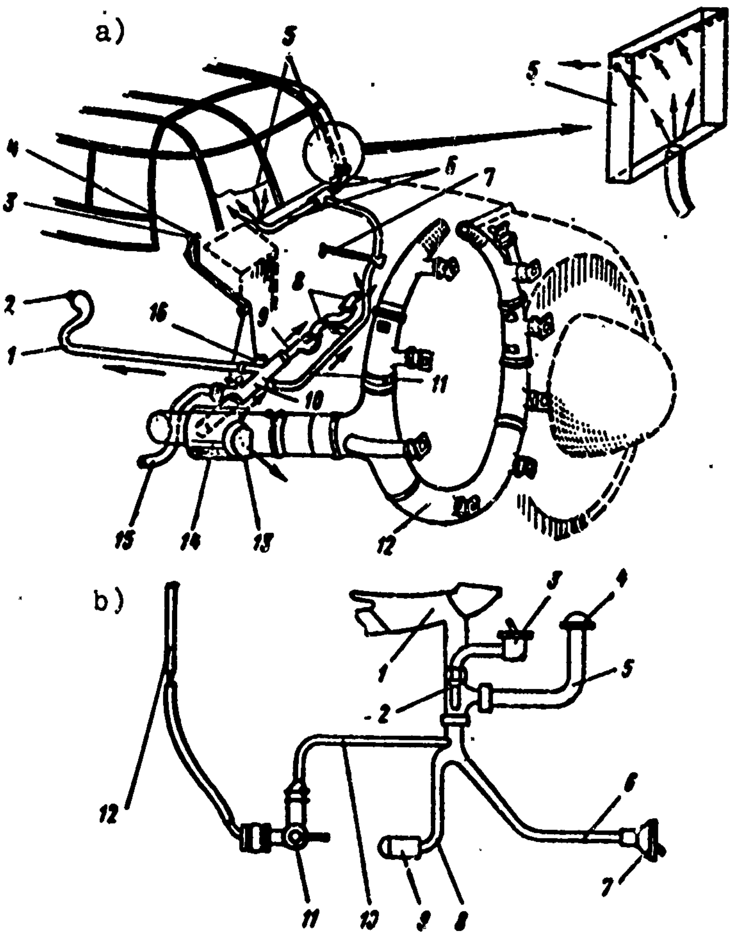

Fig. 21. Fuselage cabin heating system: a) diagram of heating of the fuselage cabin and canopy glass on aircraft up to the 37 series: 1 - warm air supply line to the cargo compartment; 2 - cargo compartment heat valve; 3 - general valve control handle; 4 - cockpit heating valve control handle; 5 - double canopy glasses; 6 - tubes; 7 - canopy glass heating valve; 8 - cockpit heating branch pipes; 9 - cockpit warm air supply line; 10 - distributor; 11 - canopy glass warm air supply line; 12 - exhaust manifold; 13 - cold air intake; 14 - heat exchanger; 15 - branch pipe for exhausting warm air outside the aircraft; 16 - recoil springs; b) schematic diagram of fuselage cabin and canopy glass heating on aircraft from the 37 series: 1 - heat exchanger; 2 - distributor; 3 - control; 4 - branch pipe for exhaust of hot air outside; 5 - outlet pipe; 6 - cargo compartment warm air supply pipe; 7 - cargo compartment heat valve; 8 - cockpit warm air supply pipe; 9 - cockpit heating branch pipe; 10 - canopy glass warm air supply pipe; 11 - copilot canopy glass heat valve; 12 - copilot's canopy glasses being warmed.

diameter of the heating tubes, improvement in the construction of the distributing valve, simplification of the tubing and increase in the power of the exhaust pipe air heater.

The distributor control is located in the cockpit on the floor on the right side of the copilot. The cockpit heating head and the canopy heat valve are located on the cockpit floor under the central panel.

Tail Compartment

In the tail compartment behind the bulkhead of frame No. 15 at the right side a lavatory is installed. Over the lavatory on the side of the fuselage a window is installed and electric lighting is supplied from a ceiling fitting. At frame No. 16 of the tail compartment exhaust ventilation is installed.

On aircraft from the 37 series a tool box is installed between frames Nos. 22 and 23.

On aircraft of the agricultural version for the prevention of the appearance of corrosion under the cargo compartment floor and the tail compartment of the fuselage during postflight maintenance and after each 100 hours of aircraft flight it is necessary to remove the panels of the cabin and tail compartment; clean under the cockpit floor at frame No. 4 and under the cargo compartment and tail compartment floor; thoroughly inspect to see if the inner skin and stiffening angle bars are damaged, if there are cracks and shear of rivets on frame No. 23.

§ 7. WING CELL.

The wing cell is biplane, single-strut type (Fig. 22), consists of upper and lower wings, two biplane struts and wire strips (two pairs of supporting and three pairs of load-carrying; the front load-carrying strips are double, the rear - single).

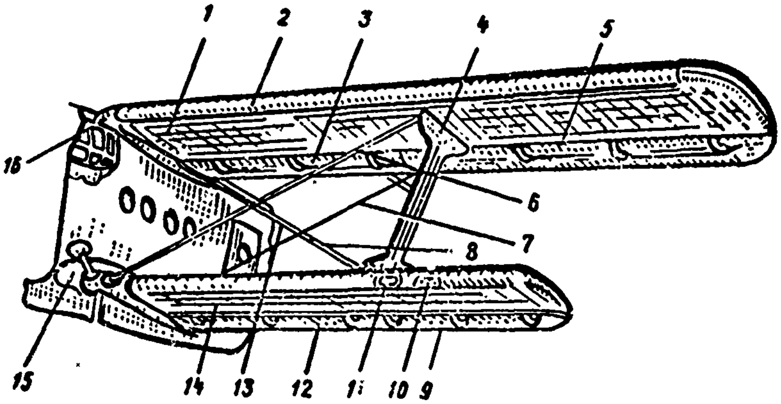

Fig. 22. Wing cell: 1 - detachable part of upper wing; 2 - slat; 3 - flap; 4 - biplane strut; 5 - aileron; 6 - front lift wire strips; 7 - aft lift wire strips; 8 - supporting wire strips; 9 - tip flap of lower wing; 10 - taxiing light opening; 11 - landing light opening; 12 - root flap of lower wing; 13 - strip holder; 14 - detachable part of lower wing; 15 - fuselage fillet with wing center section; 16 - upper wing fillet with fuselage.

The detachable parts of the upper wing are fastened to the fuselage on frames Nos. 6 and 8, and the detachable parts of the lower wing - to the spars of the wing center section by Chromansil steel joints, with ball-and-socket joints, which provides their free coupling without preliminary adjustment.

The biplane strut is fastened to the fittings at rib No. 16 of the upper detachable wing section and to rib No. 13 of the lower detachable wing section.

The wing cell is the main part of the aircraft, creating lift and receiving the weight and inertia loads. The wings receive forces from lateral flexure and twist only as components of the truss with large over-all height, formed by I-shaped biplane strut. The strut receives forces appearing with flexure and twist of the cell.

The lift wire strips in flight receive forces from lift forces, being created by the upper and lower wing. The supporting strips are loaded at rest on the ground, and they are also loaded from inertial forces when landing. The wire strips are attached to the wing and fuselage fittings through intermediate lugs, made from 30KhGSA steel.

For elimination of the vibration of dual wire strips of the biplane cell vibration dampers are installed.

Upper Wing

The upper wing is two-spar, metal construction without torsional box with unstressed fabric skin. The wing profile - constant span double-cambered, unsymmetrical, type R-PS-14%.

The planform of wing - rectangular with rounded tips.

The wing has a powerful high-lift device in the form of automatic slats, installed along the whole span, slotted flaps and flap ailerons.

The wing consists of the framework, steel joints, receiving the concentrated loads, intrawing wire strips, panels covering the fuel tank hatches, and also fabric skin from AM-93 material, which is stretched over the wing.

All the steel parts of the wing have been hardened. Duralumin parts are anodized, steel - zinc-coated.

Framework of the Detachable Part of the Upper Wing

The framework of the detachable part of the upper wing (Fig. 23) consists of 2 spars, 26 ribs, of which 9 are reinforced and 17 standard, tip and rim. The compression ribs are ribs Nos. 1, 4, 7, 10, 13, 16, 19, 22 and 25, between which are located 8 crosses of intrawing wire strips.

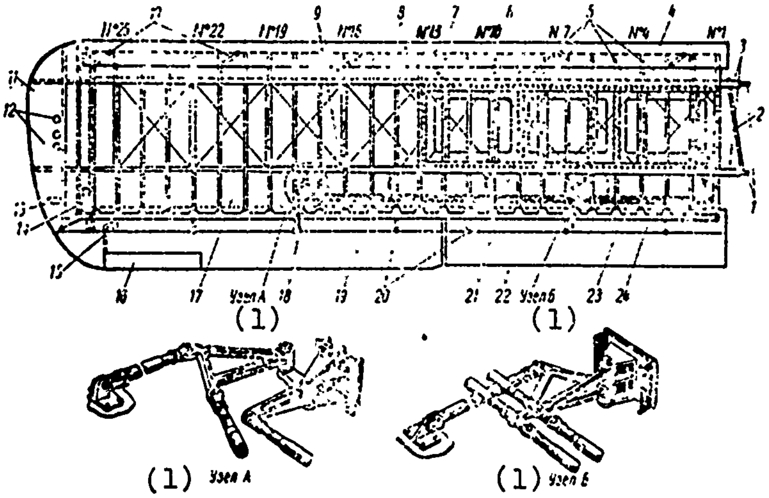

Fig. 23. Diagram of the framework of the left detachable part of the upper wing: 1 - attachment points of the wing to the fuselage; 2 - tubular strut; 3 - spars; 4 - slat; 5 - fuel tank spars; 6 - fuel tanks; 7 - shock cord of slat; 8 - intrawing wire strips; 9 - attachment points of the biplane strut to the wing; 10 - slat actuating arm; 11 - wing tip; 12 - holes for lightening; 13 - openings for assembly and disassembly of flap and aileron control rods; 14 - weight compensator of aileron; 15 - UT-6 electrical mechanism; 16 - aileron trim tab; 17 - skin of the trailing edge of the wing; 18 - aileron control rod mounting bracket; 19 - aileron; 20 - bearing brackets of ailerons and flaps; 21 - attachment of fuel hatch panels; 22 - flap; 23 - rigid flap control rods; 24 - rigid aileron control rods.

KEY: (1) Joint.

The main load-bearing elements of the wing are the spars and compression ribs, receiving flexure and twisting.

Between ribs Nos. 1 and 13 there is a compartment for the fuel tanks.

The leading edge section of the wing up to the front spar and the trailing edge section from the rear spar to the rim are covered underneath by a metal covering made from D16AT material 0.6 mm thick, which serves for imparting rigidity and the necessary shape to the frontal and aft sections of the wing.

Along the leading edge of the wing on six brackets and actuating arms along the whole span there is mounted an automatic slat. Along the trailing edge of the wing on three external brackets there is mounted the flap and on four brackets - the aileron.

On the wall of the rear wing spar there are mounted five brackets with flap and aileron control actuating arms. The spars are connected together at attachment joints by a steel tubular strut. The front spar is located on 15% of the chord, the rear - on 60%. The distance between ribs is 300 mm.

Wing Spars

The wing spars in their construction are similar to each other and are distinguished only by the sizes of components. Spars (Fig. 24) - channel section, consist of upper and lower flanges made from angle sections, and a web made from D16T sheet duralumin 0.8-1.2 mm thick.

The height of the front spar is 301 mm, rear - 216 mm. The corners of the spar flanges do not reach the theoretical airfoil contour, which allows manufacturing them from standard pressed rectangular section without beveling of edges.

The spar flanges have a cross section variable in size with respect to change of the magnitudes of bending moments in various wing sections. At the most loaded points the size of the flange changes from 45 × 45 × 5 mm at the root to 20 × 20 – at the wing tip.

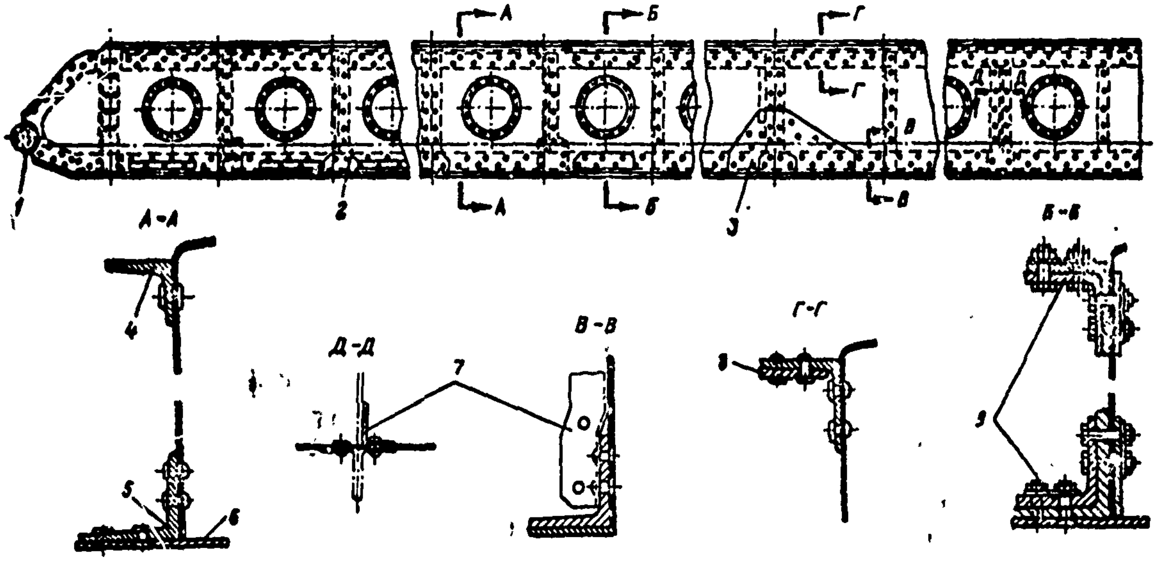

Fig. 24. Front spar of the upper wing: 1 – attachment fitting; 2 – spar web; 3 – cover plate; 4 – upper spar flange; 5 – lower spar flange; 6 – cover plate; 7 – nose attachment angles; 8 – cover plate; 9 – fish pieces.

The spar flanges spanwise have a joint between ribs Nos. 8 and 9, which simplifies the technology of their manufacture. The flanges are joined by bolts with the aid of fish pieces. The most loaded sections of the spar flanges are reinforced by D16AT duralumin cover plates 3.5-4 mm thick, which are riveted flush to the horizontal booms of the flange angles.

At the wing tip the upper booms of the flange angles are milled to 3 mm thick.

The spar webs consist of three sections, butt jointed, and have technological openings with flanging. The web of the front spar along the entire length, and the web of the rear spar between ribs Nos. 1 and 13 have a beveled edge 20 mm wide for the installation of anchor nuts for the attachment of fuel hatch covers, flanges of ribs from Nos. 14 to 26 and frontal wing covering.

The web is riveted to the flange by rivets 4 mm in diameter from D18 duralumin with a double-row seam, and at the narrowing of the flange - by a single-row rivet seam.

For attaching the nose and trailing-edge ribs and increasing the rigidity of webs to the spars are riveted angle-section struts, cut under the spar flanges at the riveting points. At the places of passage of compression ribs to spar flanges and webs the steel rib struts are fastened by bolts and steel rivets.

On the ends of the spars by Chromansil red-hot bolts there are fastened the attachment fittings of the wings (Fig. 25) with spherical bearings.

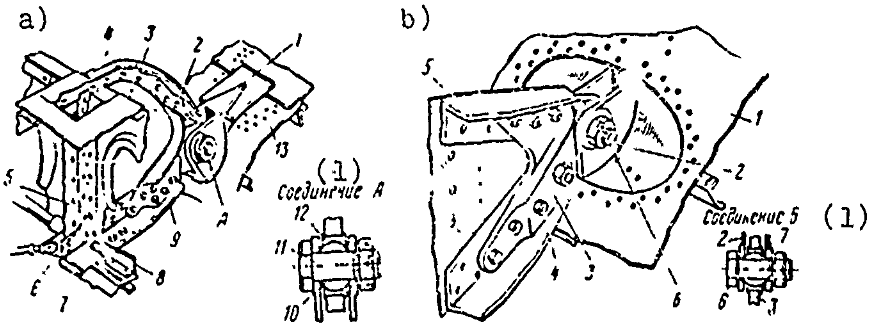

Fig. 25. The attachment fittings of the upper wing to the fuselage: a) front fitting: 1 - fuselage fitting; 2 - attachment fitting of wing; 3 - frontal covering; 4 - upper spar flange; 5 - spar web; 6 - rib strut; 7 - lower flange; 8 - rib No. 1; 9 - cover plate; 10 - spherical bearing; 11 - clamp bolt; 12 - clip; b) rear fitting: 1 - fuselage skin; 2 - fuselage fitting; 3 - wing fitting; 4 - bolt; 5 - rear spar; 6 - clamp bolt; 7 - spherical bearing.

KEY: (1) Joint.

The points of attachment of the biplane strut and wire strips at rib No. 16 are reinforced by stamped AK6 alloy brackets. On the rear spar the points of installation of mounting brackets of the flap and aileron control actuating arms are reinforced by housings cut or bent from duralumin.

To the rear spar on the section of installation of fuel tanks there is riveted a sheet duralumin cover plate 0.8 mm thick for attaching the fabric and the fuel hatch covers.

Wing Ribs

The ribs in the wing undergo flexure and compression, and they also serve for supporting the wing contour. The load-bearing configuration of the wing determined the three main types of ribs: compression, standard.and ribs of fuel tank compartments.

In the wing there are 9 compression and 17 standard ribs. The compression ribs, installed every 900 mm along the wing span, receive the entire load affecting the wing, and transfer it to the spars. Standard ribs form the wing contour and receive an insignificant load from the lift forces affecting the fabric covering.

The ribs consist of three parts: middle, nose and trailing edge.

Compression ribs (Fig. 26) consist of two welded struts, two D16T duralumin tubes 30 × 27 mm, stamped nose and trailing edge from D16AT material 0.8 mm thick with openings for lightening and flanged for rigidity.

The struts of the compression ribs are welded from two Chromansil plates 1.5 and 2 mm thick, two short branch pipes, between which a stiffening rib has been welded. The edges of the bottom plate of the strut have been unbent in the shape of eyelets for attachment of intrawing wire strips.

The struts are fastened to spar flanges with bolts, and to webs - by rivets. Duralumin tubes are inserted into the branch pipes of the struts and riveted with steel rivets. To the duralumin tubes of compression ribs Nos. 1, 16 and 25 there are riveted stamped webs made of D16T sheet 1 mm thick with openings for lightening. Vertical sides of webs are connected to the spars; on the tops and bottoms there are riveted 2NF sections for sealing the fabric.

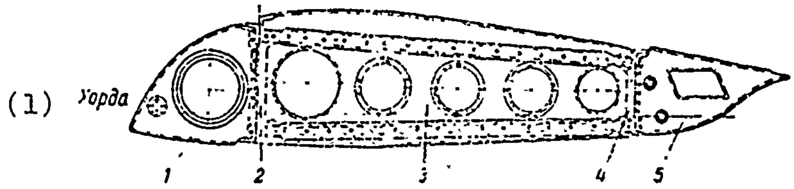

Fig. 26. Compression rib: 1 - nose; 2 - front strut; 3 - web; 4 - rear strut; 5 - trailing edge.
KEY: (1) Chord.

Compression ribs Nos. 19 and 22 do not have an upper tube, and instead of them channel sections are installed to which 2NF sections are riveted for attaching the fabric. To the duralumin tubes of the remaining compression ribs there are riveted flanges with 2NF sections.

Fuel compartment ribs (Fig. 27) Nos. 2, 3, 4, 6, 7, 8, 10, 11 and 12 in their structural form are adapted for the installation of fuel tanks and are made in the form of seats. In their middle they have only a bottom flange. The flanges of ribs Nos. 2, 6, 8 and 12 are duralumin L-beams 1.5 mm thick and serve as the support (bed) of the fuel tanks. Flanges are fastened to the spar with stamped triangular-shape knees made of D16AT duralumin 1 mm thick. Compression Ribs Nos. 4, 7 and 10 also have only the bottom flange made of duralumin tube, to which a sheet duralumin flange is riveted.

The outlines of the upper flanges of the boom of the ribs are made along the contour of the fuel tank bottoms, to which is sewn a felt cover plate 3.5 mm thick. Ribs Nos. 2, 4, 6, 8, 10 and 12 have struts with eyelets for the installation of duralumin tank attachment flanges.

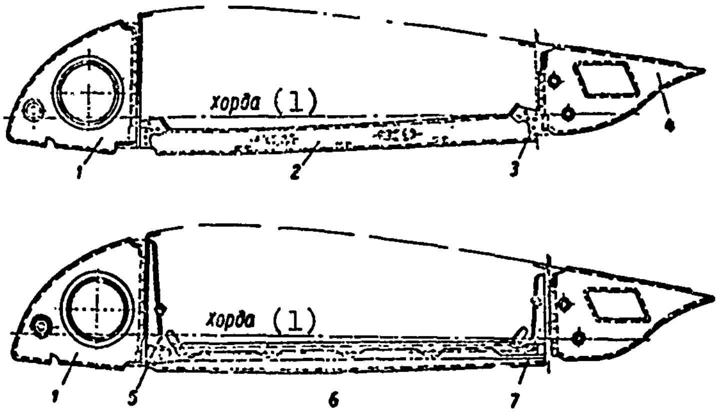

Fig. 27. Fuel section ribs: 1 - nose; 2 - seat under fuel tank (bed); 3 - knee; 4 - trailing edge; 5 - front strut; 6 - duralumin tube; 7 - rear strut.

KEY: (1) Chord.

Ribs Nos. 1, 5, 9 and 13, which limit the fuel hatches, have top flanges, to which are riveted 966A-50-5 anchor nuts for attaching the fuel tank covers.

Standard ribs (Fig. 28) are similar to one another in construction. Their middle parts consist of upper and lower C-shaped flanges made from D16T sheet duralumin 1 mm thick and connected together in the middle by a channel strut made from D16T material, riveted to the flange by rivets. On aircraft from the 156 series for reinforcement of the construction there are introduced knees (part Sh2122-0-5 and Sh2122-0-7) for attaching the strut to the flange along ribs Nos. 2, 3, 5, 6, 8, 11, 12 on the lower wing and along ribs Nos. 5 and 9 on the upper wing.

The flanges are fastened to the spar with stamped knees made from D16AT-L1 material. The knees have the shape of a triangle, one vertex of which is rounded, and two sides flanged.

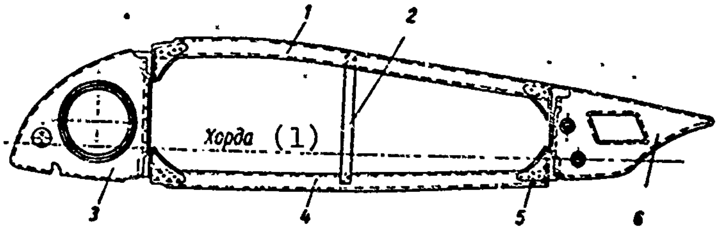

Fig. 28. Standard rib: 1 - upper flange; 2 - strut; 3 - nose; 4 - lower flange; 5 - knee; 6 - trailing edge.
KEY: (1) Chord.

To the flanges of standard ribs are riveted 2NF sections, to which fabric is attached. The middle parts of standard ribs Nos. 18 and 26 have duralumin webs 1 mm thick with openings for lightening. On the upper edges of the webs are attached 2NF sections for sealing of the fabric.

Nose and Trailing-Edge Ribs

On the lower edge of the nose and on the upper edge of the trailing edge there is riveted a section for attaching the fabric. In the trailing-edge ribs there are openings in the form of a parallelogram with rounded vertexes, whose dimensions are selected from calculation of the free passage of the aileron and flap control rods.

Noses and trailing-edge ribs are riveted to the angles installed on the spar webs. The noses and trailing-edges of compression ribs are additionally attached to spar flanges with pressed section angles. Six noses on ribs Nos. 3, 8, 13, 16, 21, 26 are reinforced by cover plates and do not have openings for lightening. The webs of these noses have grooves and serve for the installation of brackets with slat actuating arms.

To trailing-edge ribs Nos. 3, 7, 11, 14, 18, 22 and 26 before their installation on the wing there are riveted stamped bearing brackets of ailerons and flaps made from D16AT sheet duralumin 1.2 mm thick.

Intrawing Wire Strips

The wire strips are provided for the creation of rigidity of the wing framework during its operation with twisting. In the wing there are eight crosses of wire strips: five up to the attachment points of the biplane strut (rib No. 16) and three in the outer wing panel.

In the section between ribs Nos. 13 and 16 above and underneath there is a double cross of wire strips. The wire strips have oval cross section and are located in the wing chord plane.

The wire strips to the front and rear struts of the compression ribs are fastened to eyelets on the struts, bent out at a 52° angle, to which washers have been welded on. In the rib flanges, on which the fuel tanks are located, flanged oval openings are made for passage of wire strips. At the points of mutual crossover of wire strips they are connected by leather straps, riveted together.

The amount of tension of wire strips during assembly of the wing is given in Table 9.

Table 9.

(1) Тип креста лент-расчалок	Натяжение в каждой ленте, кГ (2)
(3) Крест, составленный из расчалок	
№ 9 и 6	375
» № 6	185
» № 5	120
» № 4	72

KEY: (1) Type of cross of wire strips; (2) Tension in each strip tape, kgf; (3) Cross, composed of bracing struts.

Wing Tip

The wing tip is assembled from a light duralumin framework, partially covered by a metal skin. The framework of the tip consists of two spars - front and rear, two ribs, rim and covering.

The spars - channel section, stamped from D16AT sheet duralumin 1.2 mm thick with openings for lightening, flanges for rigidity. The spars of the tip are lap jointed to the wing spars.

The ribs of the tip in their construction are similar to the standard wing ribs and consist of nose, middle and trailing edge.

The skin of the tip 0.8-1 mm thick is riveted to a second rib, spar and rim. In the middle of the skin are beaded openings for lightening. On the section adjoining the front spar the skin is reinforced by sections. On the upper part of the tail skin there is made an opening with edging, cemented by a fabric washer, which can be removed if it is necessary to remove the aileron and flap control rods from the wings. For installation of a BANO-45 aircraft navigation light on the wing tip, in the rim of the tip, skirting is made and nuts are furnished.

Wing Fittings

The attachment fittings of the upper wing to the fuselage (see Fig. 25) are stamped from 30KhGSA steel and are heat treated to $\sigma_{\text{вр}} = 120 \pm 10$ kgf/mm^2. The fittings are fastened to the spar flanges with bolts 6-8 mm in diameter made from 30KhGSA steel.

The fitting is stamped in the shape of an eyelet with two ends, which go in the direction of the spar flanges bent along the radius. Into the eyelets of the attachment fittings there are pressed inserts with grooves, into which ball cages are inserted and turned. The inserts and ball cages are made from steel 45. Such a construction of attachment fittings ensures their simple coupling with the fuselage fittings without additional adjustment.

The front attachment fitting in its lower part is connected to the welded strut of rib No. 1 by three bolts. For attachment of the tubular steel strut between the spars one of the bolts, fastening the front and rear attachment fitting, - eye bolt.

The supporting wire strips are fastened to a milled joint, bolted to the lower spar flange at the strut of rib No. 1.

The attachment points of the biplane strut (front and rear) and the lift wire strips are mounted on the lower spar flanges of the upper wing at rib No. 16. On the first series of aircraft the joints are welded to the vertical plates of the struts of rib No. 16 and technologically are an inalienable part. The eyes of the attachment points of the wire strips are reinforced with plates.

On the latest series of aircraft the joints are milled and bolted to the spar flanges of the wing with Chromansil bolts, heat treated to $\sigma_{\text{вр}} = 120 \pm 10$ kgf/mm^2. In the eyes of the joints are mounted links for attaching the lift wire strips. To the fittings are welded eyelets with ball-and-socket joints for attaching the biplane strut.

Attachment Points of the Slat to the Wing

The slat is fastened to the detachable part of the upper wing on six fittings (Fig. 29). On the compression rib noses Nos. 3, 8, 13, 16, 21 and 26 and the diaphragms riveted in the frontal section there are installed brackets stamped from AK6 material with two ribs, which form eyelets for attaching the actuating arm. The brackets are bolted to the nose and diaphragm.

Between the ribs on the link bolt revolves the stamped mounting arm of the slat, made from AK6 material. The other end of the actuating arm enters the eyelets of the steel fitting, mounted on the slat. Into the holes of both ends of the actuating arm there are pressed two No. 1008 radial double-row spherical ball bearings, ensuring free automatic opening of the slat without jamming at stalling angles.

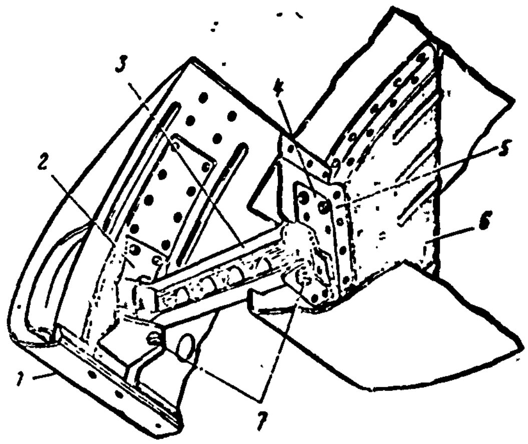

Fig. 29. Slat attachment point to the wing: 1 - slat; 2 - bracket on slat; 3 - actuating arm of slat; 4 - mounting bracket of actuating arm; 5 - diaphragm; 6 - reinforced leading edge of wing; 7 - link bolts.

On the actuating arm, installed on the No. 13 rib nose, there is attached a rubber-cord shock absorber 14 mm in diameter, the other end of which is attached on the spar. The shock absorber is designed for tightly pressing the slat to the wing. The slat is opened in flight only when the aerodynamic forces overcome the elastic forces of the shock absorber.

Slat lock. On aircraft from the 77-01 series for more reliable attachment of slats at rest there is introduced a storm lock instead of a cabin lock.

The attachment points of ailerons and flaps (Fig. 30) are curvilinear brackets made from two stamped jaws of D16AT sheet duralumin 1.2 mm thick, riveted to each other and together with the trailing-edge ribs. For attaching the bracket to the spar flanges, to the bracket on two sides there are riveted angles, which are bolted to the spar flanges.

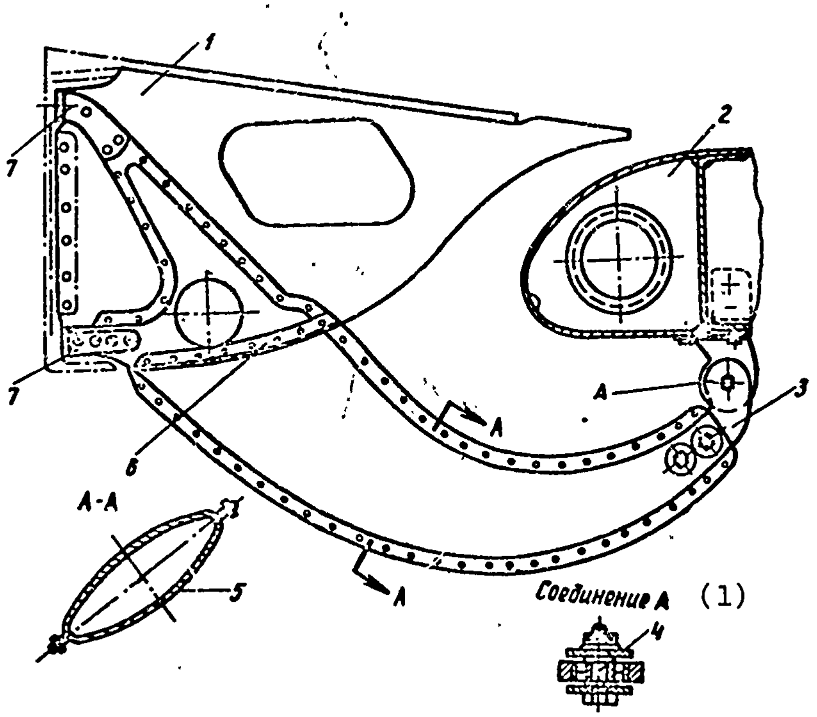

Fig. 30. The attachment point of ailerons and flaps: 1 - trailing-edge rib; 2 - aileron (flap); 3 - fork; 4 - clamp bolt; 5 - jaw; 6 - angle; 7 - spar attachment angles.

KEY: (1) Joint A.

For attaching the ailerons and flaps on the ends of the brackets between the jaws there is bolted a bracket made from AK6 material, into which the aileron or flap bracket is inserted.

The bracket is attached with a link bolt, being the axis of rotation.

The attachment points of the moving (transmitting) actuating arms of flap and aileron control are mounted on brackets of the rear spar between ribs Nos. 1 and 2, 6 and 7, 10 and 11, 14 and 15, 17 and 18.

Metal Covering, Wing Rim and Hatches

The metal covering of the wing is intended for imparting rigidity and the necessary shape to the leading-edge and trailing-edge assemblies of the wing. The leading-edge covering 0.6 mm thick is flush riveted to the sides of the nose rib by rivets 2.6 mm in diameter.

The trailing-edge metal covering is located on the bottom surface of the trailing edge of the wing, giving a certain form of slot between the wing and the controls (flap and aileron). The covering is riveted to the bottom flange of the rear spar, to the sides of trailing-edge ribs and enters the wing rim.

At the points of attachment of the biplane strut to the wing underneath to the spar flanges of the wing as well as to the leading-edge covering there is riveted a support plate.

For installing the fabric covering on the wing edge together with the covering and rim along the whole span there is riveted a 2NF section. On ribs Nos. 3, 7, 11, 14, 18, 22 and 26 in the trailing-edge covering there are made slots under the aileron and flap bearing brackets. The points of passage of the flap and aileron control rod at ribs Nos. 7 and 18 in the trailing-edge covering are edged with duralumin cover plates.

The wing rim. The trailing edge of the wing has a rim, which is a duralumin sheet 0.8 mm thick with two bent sides.

The leading edge of the rim at the points of attachment of the trailing-edge ribs is flanged, and trailing-edge covering enters the rear. The rim is attached to each trailing edge by two rivets. Lengthwise the rim consists of four segments, which are divided by cutouts under the control rods. Furthermore, at rib No. 12 there is a junction of the two rim segments.

Hatches. On the trailing-edge covering of the upper wing, at the points of installation of the aircraft control actuating arms, there are five standard inspection holes. The hole consists of duralumin edging 0.6 mm thick, a cover with a loop, catch and a coil spring of U9A material 0.6 mm thick. To the edging of the hole are attached a steel latch with a stamp-out for entry of the spring and loop for attaching the cover to the edging with the aid of a ramrod, on which, as on the axis, there is installed a catch with a spring. At the bending point of the spring to the cover is attached a guide clamp.

With finger pressure on the catch the spring is deflected and exits the latch on the edging, with this the hole is opened, and the spring returns to its initial position. The hole is shut automatically - by pressure on its cover.

During operation cracks are observed in the metal covering of the upper wing on the section between ribs Nos. 3 and 4 of the wing root at the rear spar. The formation of cracks in the covering is accompanied by considerable weakening, and sometimes by piercing of the fabric covering on this section.

On aircraft from the 83 series for the elimination of the cracks appearing on the trailing-edge covering in the area of ribs Nos. 2-5, there are introduced sections part Sh2002-0-29/30 and cover plates part Sh2002-0-31, installed between the section and the rear wing spar, the thickness of the covering in connection with this is changed from 0.8 to 0.6 mm.

Besides cracks in the metal covering of the wing there are revealed cracks in the attachment knee of rib No. 3 to the rear spar, and sometimes in the spar web. For elimination and prevention of the indicated defects during repair of the aircraft the covering is reinforced with special sections, and the standard knee is replaced by a reinforced one.

Fuel Hatch Covers

On the detachable part of the upper wing there are installed three fuel hatch covers, having curvature along the airfoil contour.

The hatch covers are stamped sheets from D16AT material 0.8 mm thick, corrugated along the chord and reinforced with Z-sections. Along the perimeter the covers have been edged with duralumin cover plates 0.8 mm thick, flush riveted to the sheets. At the points of passage of the fuel system drains the longitudinal stiffening sections are cut out and are compensated for by a lateral section in the form of a spout, made from duralumin 1 mm thick.

At the points of installation of the electric fuel gauge pickups, and also at the filler necks the hatches are placed on retaining springs. The fuel hatch covers are bolted to the wing framework with bolts with round countersunk head and anchor nuts 966A-50-5. For the installation of bolts in sheets holes are stamped at the openings, and in the framework elements the openings are countersunk.

Bolts, attaching the hatch covers to the wing, ensure their close fit, creating a contour which works under torsion.

During operation there is observed the weakening of the attachment bolts of the fuel hatch covers, which can lead to separation of the cover in air.

During maintenance of the airframe by technical personnel and during every preflight of the aircraft by the crew it is necessary to pay special attention to the state of attachment of the hatch covers to the wing framework. While walking on the front wing spar when servicing the aircraft with fuel from a refuelling truck or during check of the presence of fuel in the tanks through filler necks it is forbidden to step on the fuel hatch covers.

Wing Fabric Covering

The fabric covering of the upper wing is made from AM-93 material. The covering is sewn from panels 1350 mm wide on a machine with No. 20 thread and is stretched over the wing framework like a "stocking" so that the warp of the fabric and the seams would be parallel to the ribs. On the tip and trailing edge the skin is sewn by hand with No. 00 thread. Before stretching over, all the sharp edges of the wing framework are pasted over with cloth tape to avoid piercing the covering, and then they are coated with 138A prime coat.

To the leading-edge and trailing-edge metal covering fabric is glued with AK-20 nitrocellulose adhesive. It is tightly attached to the ribs with the aid of special 2NF sections and 3NF strips (Fig. 31). Such fastening of fabric has the following advantages as compared with its simple sewing to the ribs with thread:

1) simplicity of the technological process;

2) less labor input of the operations than with other means of fastening fabric to the ribs;

3) the more rapid removal of fabric from the entire wing or from a certain section by means of pulling the 3NF strips from the 2NF section without disturbance of the integrity of the covering and 2NF section.

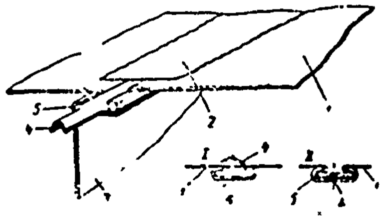

Fig. 31. The sealing of fabric on ribs: 1 - basic fabric; 2 - serrated fabric strip; 3 - rib; 4 - 3NF strip; 5 - 2NF section; I - before sealing of fabric; II - after sealing of fabric.

All the machine and hand seams, and also the attachment points of the fabric on ribs and on the edge are glued with serrated strips of LAM-3. Cutouts under the holes and openings are also glued with serrated strips and fabric washers.

At the points of exit of the aileron balancer and control rods on the wing trailing edge there are glued fairings made from aluminum-alloy AMTsM LO, 6.

At each rib at the point of its exit to the rear spar on the right are made drain holes, glued over with celluloid washers.

For improvement in the quality of coatings there is introduced painting of the fabric covering of the wings and empennage with KhV-16 vinyl perchloride enamels with the use of 9-32 lacquer as a buffer layer. With detection of defects of the lacquer and paint coatings on the fabric and metal coverings painted with vinyl perchloride enamels during operation of the An-2 aircraft, it is necessary to remove them.

The tension of the fabric is checked by a TP strain gauge. In the case of the absence of a strain gauge the tension of the fabric under operating conditions can be also checked with the aid of a load weighing 1 kg, placed on the middle of the section between the ribs. With this the deflection from the gauge, placed on the ribs up to the fabric, should not exceed 5-8 mm.

For protection of the fabric covering from piercing on the upper wing underneath along ribs Nos. 1, 2, 3, 4, 5 the material of the strips, glued at the points of attachment of the fabric to the ribs, is changed; fabric AM-93 is used instead of percale. Furthermore, a strip of AM-93 fabric has been introduced on the rear spar of the upper wing underneath between ribs Nos. 1-5.

During operation of the aircraft it is necessary to pay special attention to the state of the fabric covering on the section of ribs Nos. 1 and 5 of the upper wing. With sagging of the fabric open the fabric covering and inspect the state of the metal covering.

High-Lift Device

The high-lift device of the wing includes: automatic slats, slotted flaps and slotted flap ailerons.

The automatic slats serve for increase of lift and improvement of the lateral stability of the aircraft at high angles of attack, i.e., at low flight speeds.

Figure 32 shows a diagram of the action of forces on the slat at various angles of attack. As can be seen from the figure, at small angles of attack of the wing the aerodynamic forces press the slat to the wing, and at large, on the contrary, move it forward from the wing.

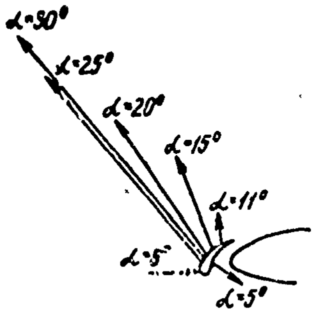

Fig. 32. The action of forces on the slat at various angles of attack.

The slat is a small wing located in front of the leading edge of the wing (Fig. 33).

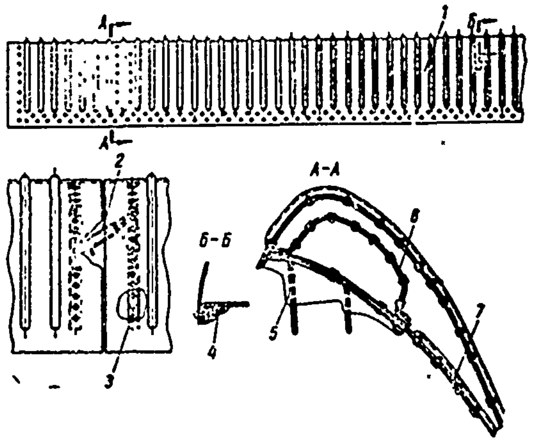

Fig. 33. Slat: 1 - upper covering; 2 - clamp with coupling in the connection of slats; 3 - rib; 4 - lath; 5 - bracket; 6 - chamber; 7 - lower covering.

On each cantilever of the upper wing there are installed two slats each, connected by a coupling and by a clamp, attached on the wing at three points each. The span of the slat is 3850 mm. The slat chord is 15% of the wing chord. The slat consists of eight ribs, a chamber, upper and lower covering and three mounting points.

Slat ribs. Spanwise at a distance of 42 mm from the edge of the covering there is located one end rib, the remaining ribs are arranged in pairs at the points of installation of the slat bearing brackets. The ribs are stamped from sheet duralumin 0.6-0.8 mm thick and attached by their sides to the upper and lower coverings. In the contour of the ribs there is made deep skirting with a side in the form of the slat chamber.

The slat chamber, made from sheet duralumin 0.3 mm thick, is located between the coverings and is riveted by its sides to the lower covering. Chamber 6 (see Fig. 33) is not installed on the slats on aircraft from the 80 series for the purpose of weight reduction and simplification of construction.

Slat covering. The upper covering of the slat is made from sheet duralumin 0.6 mm thick in form of the wing profile, has grooves with 50 mm spacing in longitudinal direction. Spanwise the covering consists of two parts, lap jointed on the center pair of ribs.

The lower covering, made from duralumin 0.5 mm thick, also has longitudinal grooves for increase of rigidity.

The upper and lower coverings are riveted along the trailing edge with two rows of rivets, staggered.

Along the leading edge of the slat to the coverings is screwed a wooden triangular lath made from whitewood. A constant clearance between the slat and the wing edge is attained by planing the lath.

On aircraft from the 35 series of the third machine there are installed reinforced slats. Reinforcement is achieved by increasing the thickness of the lower covering from 0.6 to 0.8 mm from D16A material, by the introduction of stringers and cover plates on the upper covering and by increase of the number of ribs.

Slat fittings (see Fig. 29). The bearing brackets of the slat welded from 30KhGSA sheet steel 1.2 mm thick are a plate bent along the contour of the lower skin of the slat with two eyelets welded on and washers welded on them, between which is fastened the slat mounting arm. On two sides of the bracket stiffening ribs are welded on. After welding the bracket is heat treated to $\sigma_{вр} = 100 \pm 10$ kgf/mm^2. The brackets are fastened to the slat on ribs with rivets and bolts.

All the duralumin parts of the slat are heated and anodized. The upper covering of the slat is painted with nitrocellulose enamel AGT-16, the lower - AGT-4.

Slotted flap. On the upper wing a slotted flap is installed on the section from rib No. 1 to rib No. 12. The slotted flap serves for increasing the curvature of the profile. With its deflection down the slot for the passage of airflow is opened. On takeoff, with flap deflected 25-30° there occurs considerable increase of c_y of the wing at comparatively small rise of c_x. With further flap deflection to 40° the increase of c_y continues, but c_x, which is used when landing on an area of limited size, simultaneously considerably increases.

The length of the upper wing flap is 3215 mm. The chord length - 600 mm (25% of the upper wing chord).

The flap consists of a framework, fittings and covering.

The framework of the flap (Fig. 34) consists of a spar, 13 ribs, covering and rim.

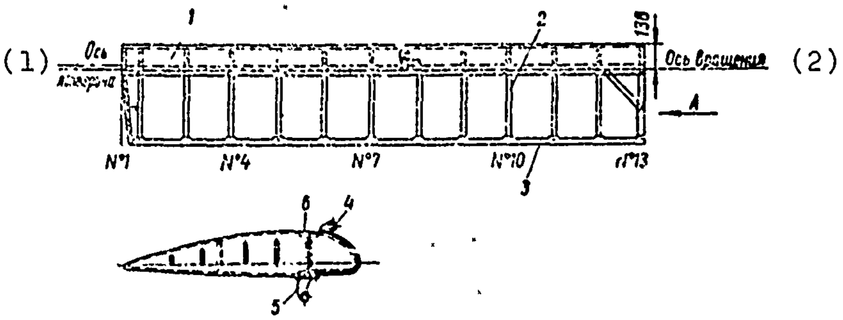

Fig. 34. Framework of the upper wing flap: 1 - leading-edge covering; 2 - rib; 3 - rim; 4 - mounting bracket of control rod; 5 - bearing bracket; 6 - spar.

KEY: (1) Axis of spar; (2) Axis of rotation.

The spar of the flap, stamped from sheet duralumin 1.2 mm thick - channel section with flanged openings. The spar spanwise consists of three sections, connected together by cover plates.

The ribs consist of nose and trailing edge. The nose ribs, stamped from sheet duralumin 0.6 mm thick, with openings for lightening, are attached by its sides to the spar and covering. At the bearing brackets there are placed reinforced noses made from duralumin 1.5 mm thick.

The trailing edges of ribs are similar to each other. They are stamped from sheet duralumin 0.6 mm thick with sides, to which 2NF sections are attached for fastening the fabric. At the trailing edge the sections are undercut, they enter the flap rim and are riveted to it. Between the ends of sections there are laid conical textolite bosses.

At the points of approach to the spar the sides of the ribs are undercut and are riveted to the sides of the spars.

The trailing edge ribs have oval openings with small sides for lightening. The end ribs have blind webs with grooves perpendicular to the chord.

The metal covering of the nose with the spar forms a closed contour, which operates on flexure and twisting. The covering, made from sheet duralumin 0.6 mm thick, is attached to the noses of the sides, to the spar and has a lap joint at rib No. 8. At the place of the joint a recess is made under the flap control rod.

The rim is made from sheet duralumin 0.8 mm thick, is bent in the shape of the contour of the shank of the bow and has flanging for attachment to the ribs.

The mounting lugs of the flap are bolted to the lower spar flange of ribs Nos. 4, 8 and 12 with bolts 5 mm in diameter. At the points of installation of the lugs the spar is reinforced by brackets, cast from AL9 alloy in the shape of angles with stiffening ribs. The mounting points are T-section brackets made from D16T duralumin with triangular base on ribs Nos. 4 and 12 and rectangular - on rib No. 8.

In the eyelets of the brackets there are made openings with double-row ball bearings No. 1006 pressed in, which ensure free flap deflection.

On the upper surface of the leading-edge covering on two reinforced noses there is located the mounting bracket of the flap control rod. The bracket has a rectangular base and is fastened to the noses by four bolts. In the eye of the bracket there is pressed a double-row spherical ball bearing. To the eye through a Cardan joint there is fastened the control rod, coming out from the wing.

During the repair of aircraft at the points of installation of the mounting lugs of flaps cracks are revealed. They appear as a result of the increased vibration of flaps and insufficient strength of the load-bearing elements, especially on the upper and lower root flaps.

The fabric covering of the flap is made similar to the wing. In the covering drain holes are made with glued celluloid washers. The aerodynamic balance of the flap is 23%.

Slotted flap aileron is installed on the cantilever part of the upper wing on the section from the flap (rib No. 12) to the wing tip. The tip of the aileron enters the wing plan contour.

The aileron has mass balancing 100% and aerodynamic balance - 21.7%.

The flap aileron consists of the framework, fittings, fabric covering and trim tab - on the left aileron.

Aileron framework. The framework of the aileron (Fig. 35) consists of a spar, 16 ribs, duralumin covering of the leading edge of the aileron and rim. On the left aileron there is located a trim tab.

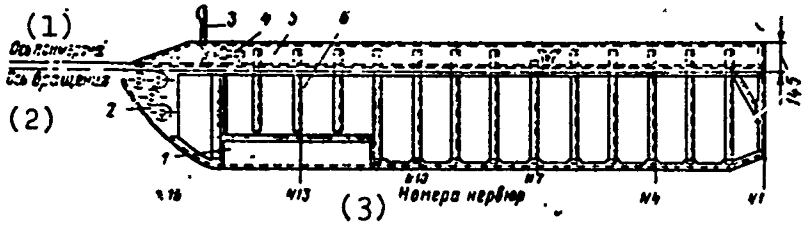

Fig. 35. Aileron framework: 1 - trim tab; 2 - tip; 3 - weight compensator; 4 - UT-6 electrical mechanism; 5 - covering; 6 - rib. KEY: (1) Axis of spar; (2) Axis of rotation; (3) Numbers of ribs.

The construction of the aileron is analogous to the construction of the flap. Spar - channel section, made from D16AT sheet duralumin 1.5 mm thick and consists of four parts, joined by cover plates.

Aileron fittings. The aileron is attached to the wing on four brackets, similar to the flap mounting brackets. The points of installation of the brackets on the lower spar flange are reinforced by cast angle brackets. On the upper spar flange between ribs Nos. 6 and 7 there is installed the aileron control rod mounting bracket with double-row ball bearing No. 1006 pressed in it.

The balance weight of the aileron is located at rib No. 15 and is fastened in a bracket made from AK6 alloy with guide bush. The bracket is attached to a special nose, made from D16AT duralumin 1 mm thick.

A lever for attaching the weight is inserted into the bush of the bracket and locked with a bolt. This weight with neutral position of the aileron enters the contour of the wing profile. The weight is cast from cast iron, is drop-like in planform, is located above the lever and is fastened to it with two bolts.

In the trailing-edge wing covering there is made a cutout with edging, and on the top surface of the wing to the fabric covering there is glued and sewn a fairing of aluminum alloy under the weight, protruding past the wing contour with aileron deflection down.

Aileron trim tab is located on the left aileron and is suspended on a loop, attached to the section which locks the shortened tailpieces of ribs Nos. 12, 13 and 14. The trim tab consists of a spar, seven ribs and covering. The spar has a channel section with sides beveled along the contour of the section. To the spar there are attached loops for attachment of the trim tab to the aileron with the aid of a ramrod, which is the axis of rotation of the trim tab.

The covering of the trim tab, made from duralumin 0.5 mm thick, is attached to the ribs and spar. The covering is riveted to ribs along the lower surface of the trim tab by hollow rivets 4 mm in diameter.

The ribs are located at a distance of 200 mm from one another and are made from D16AT duralumin 0.6 mm thick. The skirting of the ribs is riveted to the spar.

For attaching the trim tab control rod at rib No. 1 there is installed a bracket, welded from sheet steel 25. The point of installation of the bracket is reinforced by a box.

The UT-6 control mechanism of the trim tab is attached in the front part of the aileron at two points; one of them - reinforced leading edge with inserts riveted in it, through which the attachment bolt of the UT-6 mechanism passes; the second - AL9 alloy bracket is attached to the spar with a collar, which fastens the housing of the mechanism.

The fabric covering of the aileron is fastened the same as to the wing and flap. It has drain holes at the tailpiece of each rib with glued celluloid washers.

Lower Wing

The lower wing in its construction and materials used is similar to the upper wing, but it is distinguished by its size and high-lift device.

On the lower wing there are no slat, aileron, and along the whole wing span there is installed a slotted flap, which consists of two parts: root and end flaps.

In the section between ribs Nos. 14 and 15 of the right and left detachable part of the lower wing there are installed FS-155 adjustable lights. In the left detachable wing section, between ribs Nos. 16 and 17, a hole is made for an additional FR-100 taxiing light. The headlight openings are closed with folding covers, having the shape of the wing rim. The cover of the opening is attached to the wing with two "Dzus" type retaining springs and consists of two duralumin edgings, between which there is installed the glass of the headlight made of plexiglas. Between the edgings and the glass is placed a rubber gasket.

The framework of the lower wing (Fig. 36) in its construction is similar to the upper wing and consists of 2 spars, 18 ribs, of which 6 are compression, 5 wire crosses, tip, rim and covering. Between compression ribs Nos. 10 and 13 there is located a double wire cross.

On the rear spar between the trailing-edge ribs Nos. 5 and 6, 14 and 15 there are installed three-arm flap control actuators and between ribs Nos. 1 and 2, 9 and 10 there are installed transmitting arms for attaching the flap control rods. Each root and end flap is fastened to the wing on three external brackets.

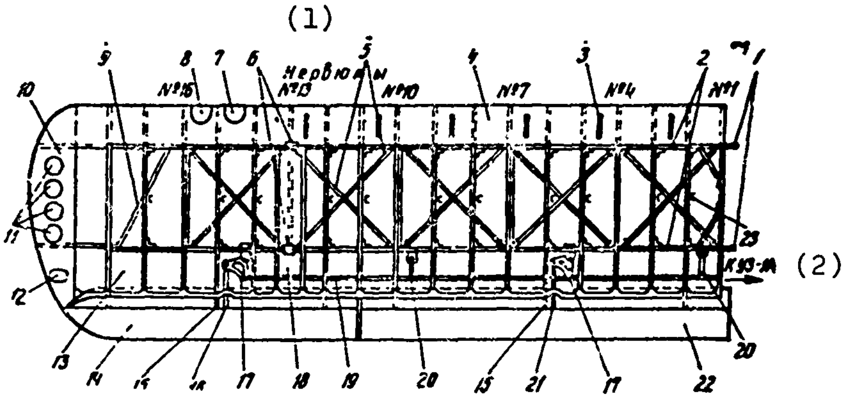

Fig. 36. Diagram of the framework of the left detachable part of the lower wing: 1 - attachment points of lower wing to the wing center section; 2 - wing spars; 3 - deformation cutouts in the covering of the wing leading edge; 4 - covering of the wing leading edge; 5 - intrawing wire strips; 6 - attachment points of biplane strut; 7 - landing light; 8 - taxiing light; 9 - duralumin wire strip; 10 - wing tip; 11 - opening for lightening; 12 - opening for assembly and disassembly of the rigid flap control rods; 13 - duralumin covering of wing trailing edge; 14 - end flap; 15 - mounting brackets of flaps to the wing; 16 - end flap control rod; 17 - three-arm actuator; 18 - duralumin support plate; 19 - flap control rod; 20 - transmitting flap control actuating arm; 21 - single-arm flap-control lever; 22 - root flap; 23 - strut of standard rib.

KEY: (1) Ribs; (2) To UZ-1A.

All the elements of the wing in their construction are similar to the correspondingly named elements of the upper wing, therefore their description is not given.

Unlike the upper wing the front covering of the lower wing between ribs Nos. 1 and 13 has notches for elimination of deformation of the wing covering, which appears with tension of the wire strips of the wing cell. The notch points of the covering are reinforced by sections and before covering with fabric the notches are pasted over with strips, having teeth along the edges.

On the wing spars at rib No. 13 there are mounted steel attachment points for the biplane strut. On the lower flange of the front spar at rib No. 13 there is installed a tiedown fitting stamped from steel 30KhGSA. The connection joints of the cantilever of the lower wing with the fuselage are shown in Fig. 37.

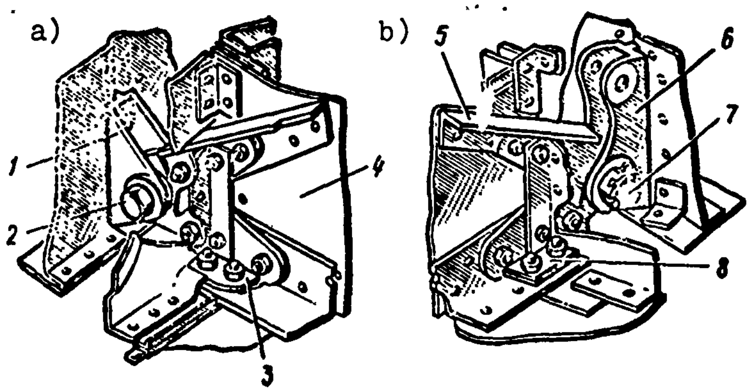

Fig. 37. Attachment joints of the lower wing to the fuselage: a) front joint: 1 - fuselage fitting; 2 - clamp bolt; 3 - wing fitting; 4 - front wing spar; b) rear joint: 5 - rear spar; 6 - fuselage fitting (attachment of wing and wire strip); 7 - clamp bolt; 8 - wing fitting.

The fastening of the lower wing covering is similar to the attachment of the upper wing covering.

On aircraft from the 103 series there has been introduced beading of the trailing-edge covering of the lower wing along the spar from rib No. 1 to 6.

For the prevention of breakthrough of the fabric on the upper and lower wing there is introduced a rubber section along the lower flange of the rear spar from rib No. 1 to 7. The GIK-1 compass pickup is installed on a bracket in the leading edge of the tip of the left lower wing between ribs Nos. 1 and 2 of the tip.

The slotted flaps of the lower wing are also similar in their construction to the flaps of the upper wing. In the root flap there are 11 ribs, in the end flap - 9. Aerodynamic balance of the flaps is 23%. The wing flap deflection is synchronous.

Biplane Strut

The biplane strut (Fig. 38), being the structural element of the wing cell, connects the spars of the upper and lower wings and receives forces appearing with flexure and twisting of the cell.

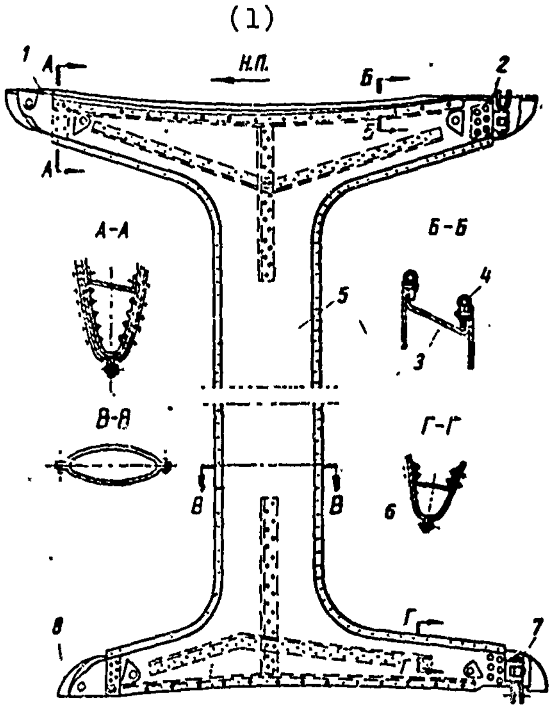

Fig. 38. Biplane strut: 1 - front attachment joint; 2 - rear attachment joint; 3 - end plate; 4 - rubber gasket; 5 - side wall; 6 - reinforcing section; 7 - adjusting screw; 8 - protector.

KEY: (1) Direction of flight.

The strut is riveted from two stamped T-section side walls, made from D16AT sheet duralumin 2.5 mm thick, and has drop-like cross section. The internal strut assembly, in its top and bottom part, serves for imparting the rigidity necessary for it. The end edges of the strut have the shape of the contour of the profile of the bottom of the upper wing and the top of the lower wing and are covered with stamped channel-section end plates made from sheet duralumin 2 mm thick with flanged openings for lightening and creation of rigidity. The end plates are fastened to the side walls with rivets and bolts. The bolts are placed for attaching the rubber buffers, which fill the slot between the edge of the strut and the surface of the wings. In the expanded part of the strut below and above there are placed additional horizontal sections, bent at the axis with radius 100 mm.

Along the axis of the biplane strut for imparting it rigidity between the side walls are riveted channel sections 2 mm thick and 300 mm long each.

All the duralumin parts of the strut are heated red-hot and anodized. The strut is fastened to the wings with two front and two rear fittings; the front fittings are fixed, the rear - are equipped with adjustable fork-type bolts. The front fittings are made from sheet steel 20 2.5 mm thick. The fittings have push fit between the side walls of the strut, to which they are attached by a double-row rivet seam. At the point of attachment of the strut to the wing half of the fittings are welded in the form of eyes, which enter the wing fittings. To the eye on two sides there are welded washers for increase in the area of resistance to buckling. With the installation of the biplane strut between the wing and strut fittings there are attached two washers each on each side.

The rear fittings of the strut are stamped from steel 45 and made in the shape of an after-piece with two eyes. The after-piece of the fitting enters the side walls of the strut and is attached to it by a double-row rivet seam. In the eyes there is an opening, which the eye bolt enters; a nut is placed between the eyes. When turning the nut the bolt moves along its axis within the length of the threaded part. The nut is saftied with wire The fittings are enclosed by fairings of duralumin 0.8 mm thick. To the end of the fairings are attached hooks, which are inserted into the clamps attached to the strut support plates of the wings. Each fairing is fastened to the strut with two "Dzus" type retaining springs.

On the left biplane strut there is installed the pitot-static tube [PVD] (ПВД) and the free-air thermometer tube.

The length of the biplane strut along the rear fittings is 1875 mm.

Wing Cell Wire Strips

For the creation of rigidity of the biplane cell in each wing half-cell there are five wire strips: two support and three lift.

The front lift and support strips are doubled. The lift wire strips work in flight on tension under the action of total forces: the load from the lift of the upper wing and the load from the lift of the lower wing, which are transferred along the biplane strut to the attachment points of the strips. Lift wire strips No. 14 have length 4320 mm; the support wire strips No. 11 have length 4030 mm.

The supporting strips are loaded at rest on the ground, and they are also loaded from inertial forces when landing the aircraft.

The front lift wire strips are attached at the bottom of the wing cell to eyes of the intermediate link of the universal joint, installed on the inclined strut of the wing center section truss, and at the top - to the milled fitting on the lower flange of the front spar of the upper wing at rib No. 16 also through a universal joint and intermediate link.

The rear lift wire strip is fastened at the bottom of the cell to the link of the universal joint installed in the upper eyes of fitting 6 (see Fig. 37b) on the rear spar of the wing center section, and at the top - to the milled fitting on the lower flange of the rear spar of the upper wing at rib No. 16.

The supporting wire strips are fastened at the top of the biplane cell to the fitting on the front spar on rib No. 1 and at the bottom - to the fitting on the front spar of the lower wing at rib No. 13.

The magnitudes of tension of the wire strips should be within the limits indicated on p. 30. Deviation from the indicated magnitudes of tension is not allowed. Tension of the wire strips is measured with a TR type strain gauge, which operates dynamically. When force is applied to the knob of the instrument, a leaf spring is deflected and the pointer shows tension in the strip. For more precise determination of tension of wire strips it is measured at three points, located at small distance from one another, and then the average instrument readings are derived.

It is necessary to remember that the tension of the dual strips should be identical (both front and rear) to avoid their breaking. For elimination of vibration of the wire strips vibration dampers are installed on the dual strips. For protection of the wire strips from shocks by dampers there are installed clips, which ensure overlap of the wire strips.

The wire strips are connected by a strip holder, which is a duralumin tube with wooden inserts. Incorrect tension of the wire strips leads to their increased vibration.

For elimination of the failure of links, wire strips and prevention of deterioration of the flight efficiencies of the aircraft it is necessary:

1) to check the tension of the wire strips after each 300 hours of aircraft flight and after each rough landing;

2) to see that there would not be weakening of the vibration dampers;

3) during repair of the aircraft to inspect the thread of the wire strips with a 20-X magnifying glass and to subject the link to magnetic check for the appearance of cracks.

The improvement in the finish of machining of the attachment links of the wire strips of the biplane cell from V5 to V6 raised their fatigue strength.

Fillets

The junctions of the upper wing with the fuselage are enclosed by easily removable fillets stamped from D16AT duralumin 0.6 mm thick and by reinforced stiffening sections. On aircraft from the 38 series the rigidity of the fillets of the upper wing to the fuselage has been raised due to increase in the thickness of the fillet material from 0.6 to 0.8 mm, in connection with this the quantity of stiffening sections on the fillets is reduced. The fillets are fastened to the wing and to the fuselage by bolts with self-locking anchor nuts, preliminarily attached to rib No. 1 of the upper wing and to the fuselage along the contour of the adjoining fillet. For increase of the airtightness of the connection of the fillet with the wing and fuselage there is introduced a rubber gasket of spongy rubber R29 3 mm thick.

The slot between the lower wing and the wing center section and the attachment point of the landing gear shock strut are enclosed by a front fairing with strips, tightened at the trailing edge of the wing by a fastener with leaf spring.

For more convenient access to the landing gear shock strut filler the hinged part of the fillet is fastened with "Dzus" type retaining springs instead of the earlier installed anchor nuts.

§ 8. TAIL SURFACE

The tail surface is single tail-fin with high semicantilever stabilizer and fin, arranged symmetrically to the longitudinal axis of the aircraft. The tail surface is of metal construction with fabric covering and consists of the elevator and rudder unit. The elevator unit includes the stabilizer with two stamped struts and an elevator with trim tab. The rudder unit consists of a fin and rudder with trim tab.

Stabilizer

The stabilizer is the longitudinal stability element of the aircraft. It has rectangular planform with rounded edges and constant symmetric profile spanwise, somewhat narrowing at the tip section.

The stabilizer consists of a frame, fittings and fabric covering.

The stabilizer frame consists of two halves, connected by cover plates along the axis of symmetry of the aircraft. Each half of the stabilizer has 2 channel-section spars, 11 ribs, 2 wire strip crosses, metal covering, covering the compartment and tip. On aircraft from the 60 series for expansion of the cg-position range of the aircraft at the stabilizer the span and the area are made larger as compared with the first series of aircraft. The span of the stabilizer is increased from 6.6 to 7.2 m, and the area from 6.99 to 7.56 m^2. In connection with this, the number of ribs in the stabilizer is increased. On aircraft from the 60 series in each half of the stabilizer there are 13 ribs (Fig. 39).

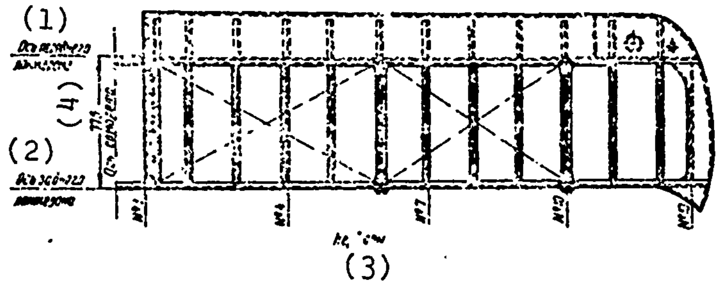

Fig. 39. Stabilizer, installed on aircraft from the 60 series.

KEY: (1) Axis of the front spar; (2) Axis of the rear spar; (3) Ribs; (4) Aircraft axis.

The channel-section spars of the stabilizer consist of the upper and lower angle-section flange and web with flanged openings for lightening and stiffening. The vertical spar angle webs are milled 2 mm each in thickness. The spar webs are made from sheet duralumin 0.6 mm thick and consist of two parts spanwise, the joining of which occurs along rib No. 6. Between the lightening holes in the spar web there are longitudinal grooves for increase of rigidity.

In the trailing edge of the spar to the web and flanges there is attached a channel-section tip spar made of DI6AT duralumin 0.8 mm thick, having variable height, corresponding to the profile of the stabilizer tip.

Along the rear spar of the stabilizer at ribs Nos. 6 and 10 there are located the elevator bearing brackets. At ribs Nos. 1, 6 and 10 on the front and rear spars there are installed struts with eyes, stamped from AK6 alloy, for attaching the couplings of the wire strips.

Each half of the stabilizer is braced with two pairs of wire strips No. 6 (GOST - 1948), the eyelets of which are fastened to struts, attached to the stabilizer spars. Maximum tension of the wire strips between ribs Nos. 1 and 6 - 200 kg and between ribs Nos. 6 and 10 - 100 kg.

The ribs are divided into compression and standard. The compression ribs are ribs Nos. 1, 6 and 10, the others - standard. The ribs consist of nose and middle. The middle parts of standard ribs - stamped from D16AT duralumin 0.6 mm thick with flanged lightening holes and grooves between them for increase of rigidity.

To the tops of the ribs are attached 2NF sections for attaching the fabric. The vertical sides of the rib are attached to the spars.

The middle parts of the compression ribs, unlike standard, are made from sheet duralumin 1 mm thick, to the sides of which are attached reinforcing sections from the same material 1 mm thick.

The compression ribs are attached to the spars by knee plates. On rib No. 6 on the front and rear spars there are located the mounting lugs of the stabilizer strut.

Rib noses - stamped from duralumin 0.6 mm thick and attached to the front spar. The front covering is attached to the sides of the rib noses.

The front covering from rib No. 1 to rib No. 8 is made from duralumin 1.2 mm thick, and on the section from rib No. 8 and to rib No. 12 - from duralumin 0.8 mm thick.

The tip of the stabilizer consists of two parts: front and interspar. The front covering is stuck together from AMTsP material 0.8 mm thick with lightening hole.

In the interspar part the tip is made from D16AT duralumin 0.8 mm thick and is reinforced by two bent sections.

The attachment points of the stabilizer to the fuselage and the fin to the stabilizer (Fig. 40) are installed by the junction of the stabilizer halves.

The stabilizer is fastened to frames Nos. 23 and 25 of the fuselage by four fittings, located on a small base. Above the mounting lugs of the stabilizer to the fuselage there are placed the mounting lugs of the fin to the stabilizer.

The fittings are made from 30KhGSA steel and are bolted to the spar flanges of the stabilizer with 30KhGSA steel bolts 5 mm in diameter. At the points of attachment of the fittings the flanges are reinforced by stamped struts, made from AK6, alloy which also serve for bracing the wire strips.

The geometric dimensions of the front and rear attachment fittings provide the installation of the stabilizer on aircraft from 1 to 60 series at a negative angle equal to 1°54', and on aircraft from the 60 series at negative angle equal to 1° to the datum line of the aircraft.

Besides the attachment of the stabilizer to fuselage frames Nos. 23 and 25 in their top part, the stabilizer is additionally attached to fuselage frame No. 25 with the aid of two T-shaped struts, connected by fittings installed on spars and rib No. 6 of the stabilizer.

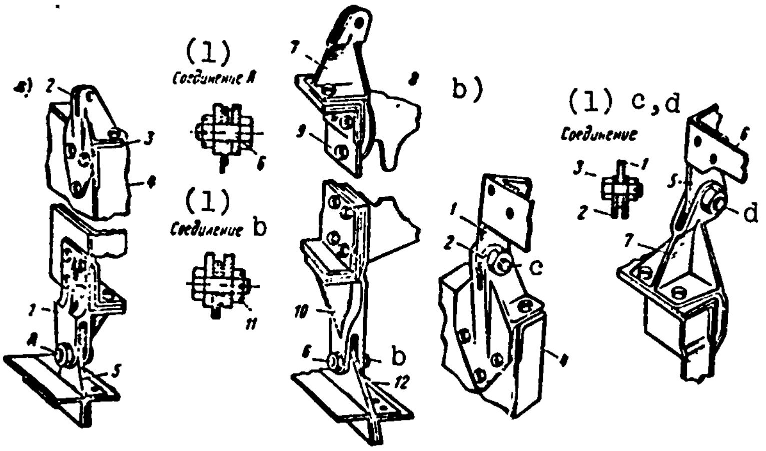

Fig. 40. Attachment fittings of the stabilizer to the fuselage and the fin to the stabilizer: a) stabilizer to fuselage attachment fittings: 1 - front attachment fitting of stabilizer to fuselage; 2 - front attachment fitting of fin; 3 - spar flange; 4 - reinforcing strut; 5 - fitting on frame No. 23; 6 - clamp bolt; 7 - rear attachment fitting of fin; 8 - central support of elevator; 9 - reinforcing strut; 10 - rear attachment fitting of stabilizer to fuselage; 11 - clamp bolt; 12 - fitting fuselage on frame No. 25; b) fin to stabilizer attachment fitting: 1 - front fitting of fin spar; 2 - front top fitting on the stabilizer spar; 3 - clamp bolt; 4 - reinforcing strut on the stabilizer spar; 5 - rear fitting of fin spar; 6 - covering; 7 - rear attachment fitting of fin to stabilizer.

KEY: (1) Connection______.

The strut mounting lugs are made from 30KhGSA steel, are screwed into the vertical parts of the brace strut fittings and are locked with nuts. The attachment fittings of the brace struts on the front spar are forks and are bolted to the spar with two bolts. Fittings on the rear spar are made together with the fittings, on which the elevator mounting arms are fastened. Brackets for installation of the elevator mounting arms are milled and manufactured from 30KhGSA steel, are installed on the upper and lower flanges of the rear stabilizer spar and are bolted to them.

The stabilizer is covered with AM-93 fabric similar to the wing. At the ribs across the bottom surface there are drain holes. All the machine seams and attachment points of fabric to the ribs are pasted with serrated strips.

The stabilizer strut connects the stabilizer cantilever to the fuselage and is subject to tension and compression, transferring the load from the elevator unit to the main fuselage frame No. 25. The strut consists of two stamped side walls of D16AT-L2 material riveted together. At the points of attachment of the strut to the stabilizer between the side walls there are riveted fittings stamped from AK6 alloy (Fig. 41, connection B), into which there are screwed adjusting bolts with lock nuts.

For installation of the bottom adjusting bolt in the bottom of the strut, between the side walls, there is riveted an eyelet with two fins, stamped from 30KhGSA steel and heat treated. In the middle of the eye there is a boss, in which a hole is drilled and a thread is cut. Into the hole is screwed an adjusting eye bolt made from 30KhGSA steel with a lock nut (see Fig. 41, fitting A).

During operation there took place cases of the appearance of cracks in the upper fittings of strut 3 as a result of the presence of poisonous chemicals and the appearance of corrosion. For prevention of this defect and protection of the threaded part of the fittings of the stabilizer strut from poisonous chemicals from aircraft of the 125 series (agricultural version) rubber caps are placed on the front fittings.

On aircraft of the 136 series the threaded part of the fittings of the stabilizer struts is reinforced by change of R10.5 to R11.5 and displacement of the radius by 1 mm.

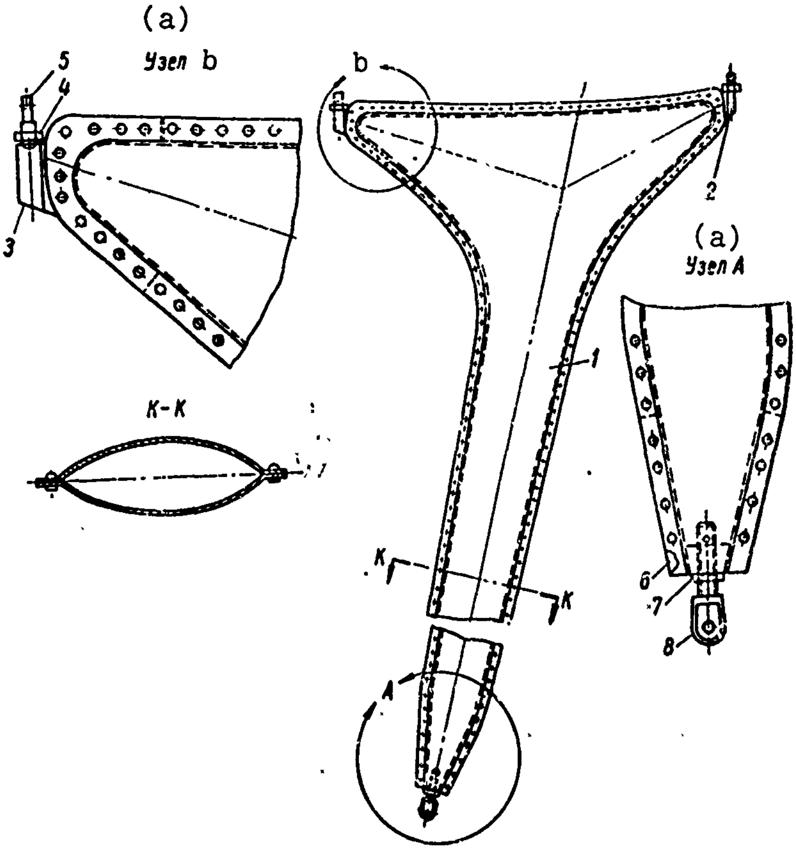

Fig. 41. Stabilizer strut: 1 - side wall of strut; 2 - rear fitting of strut; 3 - front fitting of strut; 4 - lock nut; 5 - fork-type bolt; 6 - lower fitting of strut; 7 - lock nut; 8 - fork-type bolt.

KEY: (a) Fitting___.

The diagonal brace strut of the stabilizer connects the rear stabilizer spar with the fitting installed on the top of frame No. 23, and it serves for supporting the rear spar at the point of installation of the central elevator support.

The diagonal brace strut of welded construction is two 30KhGSA steel tubes welded at an angle. At the welding point of the tube there are cut grooves, into which is welded a stamped eyelet made from 30KhGSA steel used for attaching the diagonal brace strut to fuselage frame No. 23.

The tubes are pressed to stabilizer at the attachment points and grooves are made in them, into which are welded inserts, bent from sheet 30KhGSA steel 1 mm thick.

Elevator

The elevator consists of two halves, symmetrically arranged relative to the longitudinal axis of the aircraft and connected together with the aid of flanges by four bolts.

The elevator enters the overall profile of the elevator unit and is mounted at five points to the rear stabilizer spar. The leading edge of the elevator is parallel to the stabilizer spar and is rounded on the ends. On the left half of the elevator, on the trailing edge, a trim tab is installed.

The elevator has 24% aerodynamic balance, facilitating elevator control, and 105% mass balancing, protecting the elevator from vibrations in the entire speed range.

Each half of the elevator consists of a duralumin frame, mounting lugs and balancing fittings.

The frame of the elevator (Fig. 42) consists of spar, ribs, rim and covering.

The spars - channel section of constant height, made from D16AT duralumin 1.2 mm thick. In the spar web there are made lightening holes with flanges for stiffening. Under the elevator mounting brackets at ribs Nos. 6 and 10 in the spar there are made shaped cutouts. The cutout places are reinforced by channel-section cover plates and by cast brackets made of AL9 material, riveted to the spar.

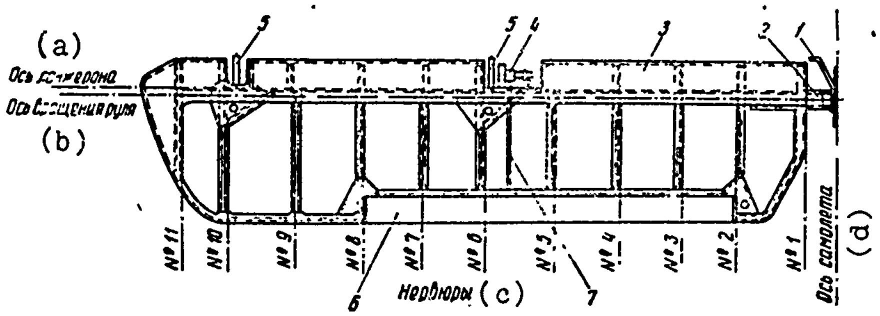

Fig. 42. Diagram of the elevator frame: 1 - central stabilizer bracket; 2 - duralumin tube; 3 - covering; 4 - UT-6 trim-tab control electrical mechanism; 5 - elevator mounting bracket to stabilizer; 6 - trim tab; 7 - trim tab control rod.

KEY: (a) Axis of spar; (b) Axis of rotation of elevator; (c) Ribs; (d) Axis of aircraft.

The elevator hinge line passes from behind the spar, therefore at the places of cutouts, from the rear of the spar, on six bolts there are attached the elevator mounting brackets, made from D16 duralumin, between the ribs of which are placed the elevator mounting arms.

In the cantilever part, outside the mounting point, the spar web is made from sheet duralumin 0.8 mm thick, with variable height, corresponding to the tip profile thickness.

At the junction of both halves of the elevator to the spar is attached a D16AT duralumin tube, reinforced by a section. On the tube are attached flanges, which serve for connection of both halves of the elevator. Between the flanges is installed the elevator control actuating arm. In the flanges of spars and in the actuating arm there are holes, through which passes four bolts for connecting both halves of the elevator together.

To the elevator spar are attached 12 ribs, each of which, except the first, consists of a nose and trailing edge. Rib No. 1 is stamped from a whole D16AT plate 0.8 mm thick, has bent form, closing the end of the elevator, and at rib No. 2 changes into the rim, being connected to it with the aid of a textolite lug.

The rib noses at the point of installation of the control brackets are doubled and create a slot for passage of the brackets. At the ribs in the trim tab zone there are cut ends to the chord length of the trim tab and to them is attached a channel section for mounting the trim tab.

The front covering on the section from rib No. 1 to rib No. 6 is made from duralumin 0.8 mm thick and from rib No. 6 to rib No. 10 - from duralumin 0.6 mm thick. The front covering at the mounting brackets is reinforced on two sides by knees, which connect the covering with the side of the rib and with the spar.

The rim of the elevator is made from D16AT material 0.8 mm thick and is similar in its construction to the rim of the spar and flaps.

The elevator is suspended on the rear spar on five fittings. Along the axis of the aircraft is installed the central support of the elevator (Fig. 43b); the other four fittings (Fig. 43a) are installed on ribs Nos. 6 and 10 of the right and left stabilizer halves.

The central support of the elevator consists of two brackets cut from duralumin, connected by a spacer. In the bracket there is placed a single-arm elevator control lever, made of duralumin. In the lever there are two holes under the ball bearings and four holes for the passage of bolts attaching both halves of

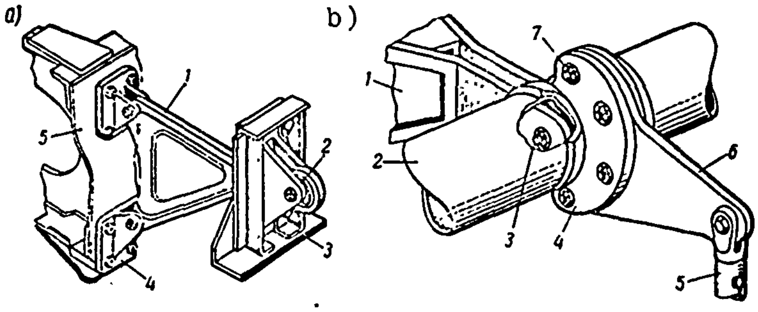

Fig. 43. The elevator attachment points: a) lateral elevator attachment point: 1 - mounting bracket of elevator; 2 - bracket on elevator; 3 - elevator spar; 4 - bracket on stabilizer; 5 - stabilizer spar; b) fitting of the elevator central support: 1 - bracket; 2 - elevator tube; 3 - axial bolt; 4 - elevator flange with four holes; 5 - elevator control rod; 6 - single actuating arm of elevator; 7 - four connecting bolts of both elevator halves.

the elevator together. One hole with a double-row ball bearing serves for installation of the bolt (elevator hinge line), in the second hole with ball bearing there is installed the bolt of the elevator control rod.

The brackets on stabilizer ribs Nos. 6 and 10 of triangular shape are stamped from AK6 alloy. The two ends of the bracket are fastened to the stabilizer spar, a ball bearing is pressed into the third . The bracket with its extended end enters between the ribs of the brackets, installed on the elevator spar, and is bolted to them. For access to the fittings underneath the elevator there are openings, sealed with a fabric washer.

The mass balance weights are installed in both halves of the elevator. A fixed weight is installed between ribs Nos. 8 and 9 and is a forging made of steel 25, machined along the contour of the leading edge of the elevator. To the weight are welded ribs, which are attached to the leading edges of the elevator.

The adjusting weight is a steel 25 bolt 24 mm in diameter, which is installed between ribs Nos. 1 and 2 in the nose section in the welded bracket, which consists of two plates, between which is inserted a nut with tubes. The brackets are bolted to the leading edges of the elevator. Balance is accomplished by decreasing the length of the adjusting bolt.

The elevator trim tab is installed on the left half of the elevator between ribs Nos. 2 and 8. The trim tab consists of a channel-section spar, ribs and covering. The trim tab is attached on the elevator similar to the attachment of the trim tab on the aileron. On separate aircraft in the ATB (Air technical base) of civil aviation a trim tab plate is installed on the trim tab.

Trim-tab control is electric remote and is accomplished from the UT-6D electrical mechanism. The electrical mechanism is installed on an elevator spar, in the section between ribs Nos. 5 and 6, from which the control rod goes to the bracket, riveted to the spar of the trim tab. The mechanism is bolted to the reinforced leading edge of the elevator, to which a milled insert is riveted. The second support of the mechanism is a cast bracket with a riveted clip, which surrounds the housing of the mechanism. The hatch of the electrical mechanism is closed with a cover, which is bolted to the leading edge and the spar.

The elevator is covered with AM-93 fabric, which is attached to the elevator frame similar to the flap and aileron.

Fin

The fin is a directional stability element, has triangular shape with rounded top and consists of a duralumin frame and fittings.

The frame of the fin (Fig. 44) consists of two spars, seven ribs, two diagonal brace struts and metal covering. All the parts of the fin are heated red-hot and anodized.

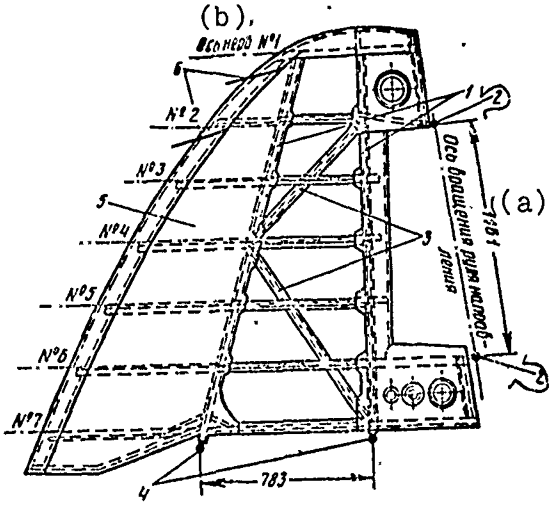

Fig. 44. Frame of the fin: 1 - spars; 2 - mounting points of the rudder; 3 - diagonal brace struts; 4 - fin attachment fittings to stabilizer; 5 - covering; 6 - attachment points of RSB-5 and ARK-5 antennas.

KEY: (a) Rudder hinge line; (b) Axis of rib No. 1.

The front spar is inclined toward the rear spar. The rear spar is installed vertically with respect to the longitudinal axis of the aircraft.

The spars - channel-section with curved sides, which are flanged at the points of installation of the ribs. The spars - variable section, narrowing upwards. In the spar web are made openings, flanged for rigidity. At the lower end of the spar to the web and its sides with 5 mm diameter rivets there are riveted the attachment fittings of the spar to the stabilizer.

In the fin are seven ribs. Rib No. 1 is one-piece, stamped from D16AT duralumin. Ribs Nos. 2, 6 and 7 consist of nose, middle and trailing edge. The remaining ribs consist of nose and middle.

The rib noses are made from sheet duralumin 0.8 mm thick, do not have structural distinctions and are distinguished from one another only by dimensions. The noses have lightening holes flanged for rigidity and vertical sides for attaching to the front spar with rivets 3 mm in diameter.

The middle parts of the ribs are also similar in their construction, are made from duralumin 0.6 mm thick, have flanged lightening holes and transverse grooves for rigidity. To the sides of the middle part are riveted 2NF sections for attaching the fabric. By the vertical sides of the middle of the ribs in accordance with the noses and trailing edges they are riveted to the spars.

Rib No. 7 of the fin is an end compression rib. The nose is made from duralumin 0.8 mm thick, is curved and has flanged lightening holes, between which are located transverse grooves for rigidity.

The middle of the rib is made from D16AT material 1.2 mm thick with lightening holes and transverse grooves for rigidity.

To the sides of the nose and middle of rib No. 7 are attached anchor nuts for fastening the tail unit fillets.

The section of the fin between the spars is reinforced by two diagonal brace struts stamped from sheet duralumin 0.8 mm thick with lightening holes and transverse grooves. The diagonal brace struts intersect the middle parts of ribs Nos. 3, 5 and 6 through special openings and are attached to the front spar at rib No. 4 and to the rear spar at ribs Nos. 2 and 7.

The diagonal brace struts are connected to ribs at the point of their mutual intersection with angle bends made of duralumin 0.8 mm thick, which are riveted to the frame and rib.

The leading edge of the fin is covered with a duralumin covering 0.8 mm thick. From the leading edge to the front spar a covering 0.6 mm thick with stiffening grooves is riveted to the rib noses and to the spar. A duralumin covering 0.8 mm thick covers the section between rib No. 1 and the trailing edge of rib No. 2 with one flanged hole, and in the bottom part between ribs Nos. 6 and 7 there is installed a section of covering 1.2 mm thick with three flanged lightening holes.

For reduction of the slot between the rear fin post and the axial rudder balance on the section between ribs Nos. 2 and 6 there is riveted a sheet of covering 0.6 mm thick with small sides, reinforced at the access points to the spar of the ribs by duralumin brackets, having the shape of the rudder profile.

In the upper part of the fin from rib No. 1 to the edge there is installed the tip of the fin, consisting of a covering 0.8 mm thick, which is reinforced by longitudinal stiffening sections and by transverse grooves.

The fin attachment fittings to the stabilizer (see Fig. 40b) are made from 30KhGSA steel 5 mm thick with subsequent milling of the adjoining planes to the spar and eye joints.

The fittings are heat treated to $\sigma_{\text{Bp}} = 100 \pm 10$ kgf/mm^2 and are fastened to the front and rear fin post with rivets 4-5 mm in diameter.

The mounting points of the rudder are stamped from AK6 alloy and are eyelets with two tail-pieces, which are attached to the trailing edges of ribs Nos. 2 and 6 by rivets 5 mm in diameter. The fittings are heat treated and anodized. The trailing edge of rib No. 6 at the riveting place of the fitting is reinforced by two duralumin sections 1 mm thick.

To the front spar at ribs Nos. 1 and 2 are fastened the RSB-5 communication radio and ARK-5 radio compass antennas. For this to the fin post there is riveted a duralumin bracket 1 mm thick, to which is fastened a spring with wire core, connected with cable, braided to the eye.

The fabric covering of the fin is attached to the fin frame similar to the earlier described units.

Rudder

The rudder is fastened to the fin and fuselage on three fittings. Two units - to the fin and the third - to fuselage frame No. 6. The rudder consists of frame, fittings, fabric covering and trim tab.

The rudder frame (Fig. 45) has a spar, 12 ribs, front covering and trim tab profile. All the duralumin parts of the frame are heated red-hot and anodized. The rudder spar - channel section with lightening holes flanged for rigidity. The spar has a cross section variable in height, which smoothly narrows upwards. The spar is made from D16T sheet duralumin 1.5 mm thick.

From rib No. 11 and to the bottom edge of the rudder the spar passes into the web, made of duralumin 0.8 mm thick. At the

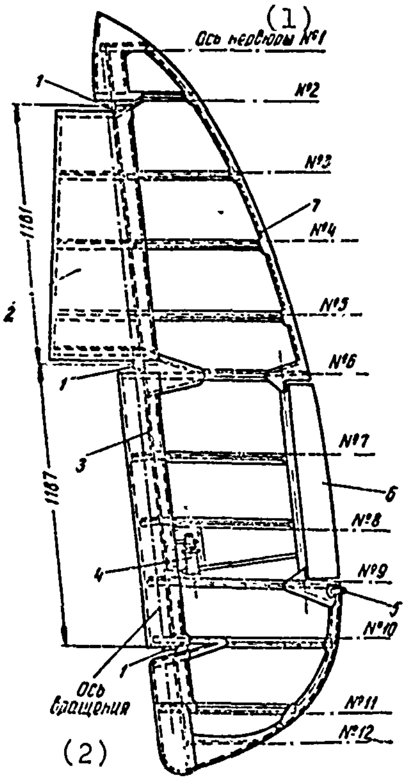

Fig. 45. Frame of the rudder: 1 - attachment fittings of the rudder to the fin and fuselage; 2 - aerodynamic compensator; 3 - spar; 4 - UT-6 electrical mechanism; 5 - tail ANO (navigation lights); 6 - trim tab; 7 - rim.

KEY: (1) Axis of rib; (2) Hinge line.

points of installation of the rudder mounting brackets there are placed channel-section duralumin boxes 1.5 mm thick. The spar has inclination with respect to the vertical axis of the aircraft. The ribs of the rudder, with the exception of Nos. 1 and 12, are slotted, have variable dimensions chordwise and along the height of the bow and consist of nose and trailing edge, made of duralumin 0.6 mm thick. Ribs have lightening holes.

The rib noses on the section from rib No. 6 to rib No. 10 are perpendicular to the spar and at the spar have a break with respect to the rib. The noses at the rudder mounting brackets are doubled, form a slot for the passage of actuating arms and are connected to the spar by duralumin knees 0.8 mm thick riveted on two sides. The trailing edges of the ribs are locked by a sheet duralumin rim 0.6 mm thick. The rim has sides, bent back on the access sections of the ribs.

In the bottom part of the rudder to the rim is riveted an expanded section in the form of a base, connected with rib No. 12 and with the section of the web which closes the spar.

The top part of the rudder is covered by a tip, welded from AMTsAP alloy 0.6 mm thick, riveted to the spar, rim, rib No. 1 and rib No. 2 nose.

On the section from rib No. 6 to rib No. 9 the trailing edges of ribs are shortened to the length of the trim tab and with the aid of angle bends a channel section with a loop for mounting the trim tab is attached to the ribs. Ribs Nos. 6 and 9 at the place of installation of the trim tab are connected to the rim with knees, where the bottom knees have a knockout, into which is inserted a tube under the aircraft navigation light. In the knees through eyelets are placed under the gust locks of the rudder and elevator.

The leading-edge covering of the rudder 0.6 mm thick consists of three sections. All the sections are riveted to the rib noses and to the spar and have a small side behind the spar.

On the section from rib No. 2 to rib No. 6 the rudder has an axial aerodynamic compensator; aerodynamic balance - 19%.

On the section from rib No. 6 to rib No. 10 in the covering two holes are made under the wiring, which are reinforced with riveted edgings.

The attachment fittings of the rudder (Fig. 46a) are installed on the fin post at ribs Nos. 2 and 6 and fasten the rudder to the fin. The fittings consist of two elements: bracket, milled from D16 duralumin, with two eyes at the link. The bracket is fastened to the spar by four bolts.

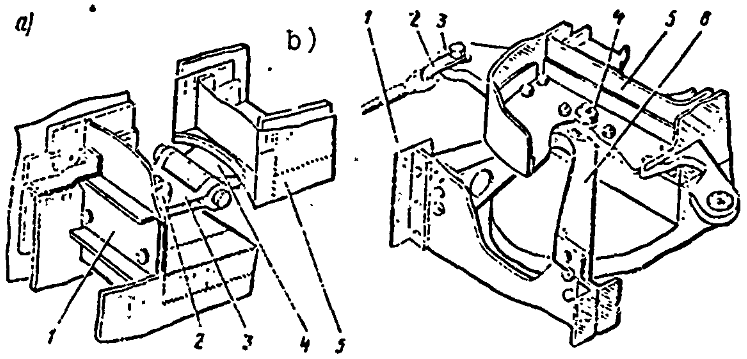

Fig. 46. Attachment fittings of the rudder: a) attachment fittings of the rudder to the fin: 1 - cover plate; 2 - fin bracket; 3 - link; 4 - rudder bracket; 5 - rudder; b) lower attachment fitting of the rudder to frame No. 26: 1 - frame No. 26; 2 - link; 3 - lever; 4 - clamp bolt; 5 - rudder; 6 - bracket.

The link enters the eye of the bracket with the end, into which a ball bearing is pressed. The other end of the link is a fork, which the bracket, riveted to the trailing edge of the rudder rib, enters.

The bottom mounting bracket of the rudder to fuselage frame No. 26 (Fig. 46b) serves simultaneously as a double-arm lever, to which the rudder control cables are attached. The bracket - stamped from AK6 alloy, symmetric relative to the horizontal axis. The shape of the bracket stamping ensures its fitting to the rudder spar at rib No. 10.

The bracket in the center has a boss with a square opening, into which is inserted the clamp bolt, serving as the hinge line of the rudder.

Into the eyes of the bracket are pressed ball bearings, which the control cables approach. The bracket is fastened to the spar with bolts and rivets.

In the detachable bracket on fuselage frame No. 26 there is pressed a radial thrust ball bearing, which ensures free turning of the rudder.

The weight compensator of the rudder is installed in the aerodynamic compensator between ribs Nos. 4 and 6 and is a weight with two welded plates for attaching it to the ribs. In the end of the weight a hole is drilled, in which a thread is cut. Into this hole a bolt is screwed, by decrease of the length of which the rudder balance is attained. Mass balancing of the rudder is 100%.

The rudder trim tab consists of a spar, five ribs and covering. In its construction the rudder trim tab is similar to the aileron and elevator trim tabs with the exception of the contour of the trailing edge of the trim tab.

Trim-tab control - electric remote and is accomplished by the UT6D electrical mechanism, which is installed between ribs Nos. 6 and 9 behind the spar. From the electrical mechanism a control rod runs to a bracket, riveted to the spar of the trim tab.

The place of installation of the electrical mechanism is edged with sections and closed with a hatch cover, suspended on a loop. The hatch cover is closed by two "Dzus" locks.

The rudder covering is made from AM-93 fabric, is glued to the metal covering and is fastened with strips to the rib sections similar to the earlier described units.

In the bottom part of the rudder in the metal base there are drilled three drain holes, pasted over with celluloid washers.

For locking the controls and ailerons on the aircraft there is a cockpit lock. The lock is painted red. In addition to the cockpit lock to the elevator and rudder there is installed a gust lock in the form of wire cables with clamps for tightening the cables.

CHAPTER III

TAKEOFF AND LANDING DEVICES

Takeoff and landing devices include: landing gear, tail wheel installation, pneumatic brake control system of the wheels and skis, flaps and slats.

The landing gear in flight are fixed, with inverted type hydropneumatic shock absorbers. The tail wheel is self-aligning.

The pneumatic system of the aircraft serves for braking the wheels and skis, recharging the shock-absorber struts and landing gear wheels under field conditions, and also control of the agricultural equipment.

§ 9. LANDING GEAR

The landing gear (Fig. 47) receives the loads affecting the aircraft during its takeoff, landing, movement over the ground and at rest.

The landing gear - pyramid type, consists of two separate halves. Each half of the landing gear is assembled from two (front and rear) struts, shock strut, semiaxle, on which a medium-pressure type wheel is mounted with bilateral pneumatic

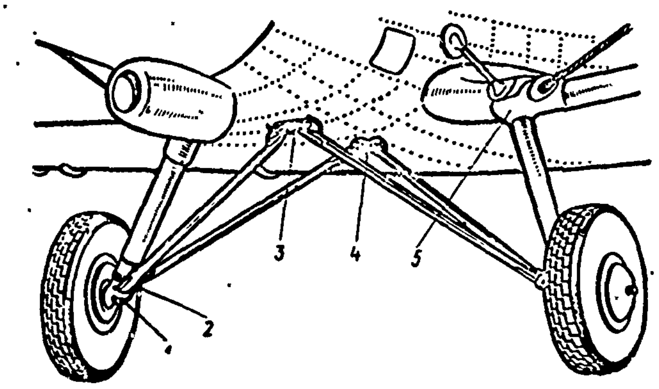

Fig. 47. Aircraft landing gear: 1 - semiaxle mounting lug to front strut; 2 - mounting lug of rear strut to front strut; 3 - mounting lug of front struts to fuselage frame No. 4; 4 - mounting lug of rear struts to fuselage frame No. 6; 5 - shock absorber mounting lug fairing.

drum brake, in winter - skis. The shock struts are enclosed by a double-leaf fairing, assembled on a ramrod and on four retaining springs. For determination of the degree of settling of the aircraft on the latest series the fairings of the shock struts have folding covers.

A design feature of the landing gear is that during the shock absorber stroke all the rods change their position, with this the forward struts revolve around their axes, the cylinders of the shock absorbers turn on the rods, and the wheels change inclination both toward the vertical and the longitudinal axis of the aircraft.

Hinged Joints of the Landing Gear

The front and rear struts with the top fittings are fastened to the shoes, installed along the axis of the aircraft underneath the fuselage on frames Nos. 4 and 6. The forward strut is connected to the shoe by means of a ball-and-socket joint (fitting A), rear - by means of universal joint (fitting B). The shock struts with upper fittings are joined with the fittings of the wing center section truss (fitting C). The front strut in its bottom part is connected to the rear strut by a hinge (fitting D) and with semiaxle - by a rack (fitting E).

The construction of the landing gear fittings is shown in Fig. 48.

Fitting E is made in the shape of a rack, receives all the loads appearing with front and side shock to the wheel.

The attachment bolts of the front and rear struts to the shoes of the fuselage and shock struts - to the wing center section pyramid, and also the attachment bolt of the rear strut to the front strut have valve grease cups for stuffing lubricant into the joints.

Struts

The forward struts are made from two stamped halves of Chromansil steel 2.5 mm thick, welded together on the front and trailing edge. The struts have variable profile with increase in cross section towards the rack. At the end of the strut the stamped fittings are fitted and welded on.

The upper attachment fitting of the forward struts finishes in an eyelet, into which is pressed a standard spherical bearing. The bearing consists of a race with a spherical seat, into which is placed a cemented spherical sleeve bearing. The edge of the race protruding from the eyelet of the strut after press-fitting is flaired.

The bottom fitting finishes in a rack with two eyes. In the rear eye there is a ball-and-socket attachment joint of the rear

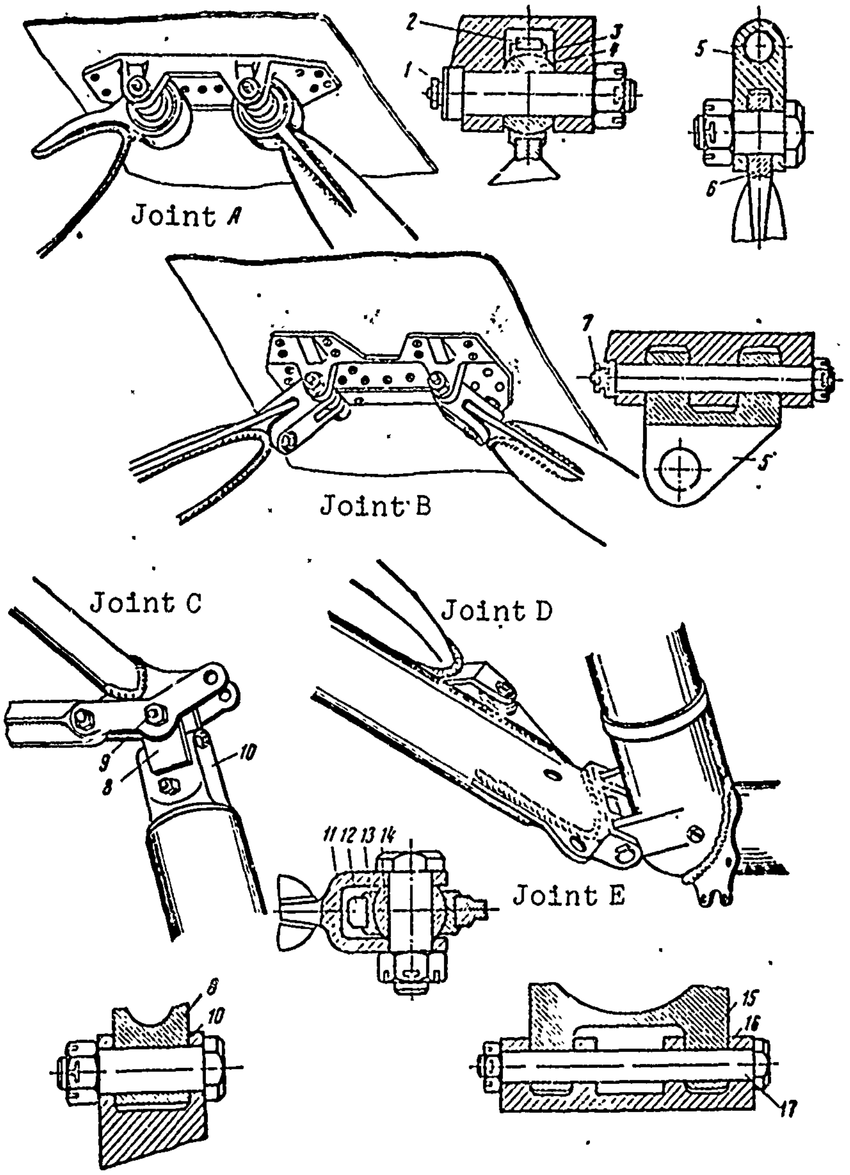
Joint A
1
2
3
4
5
6
Joint B
7
5
Joint C
9
8
10
Joint D
11 12 13 14
Joint E
8
10
15
16
17

Fig. 48. Hinged joints of the landing gear: A - attachment fitting of the forward struts; B - attachment fitting of the rear struts; C - attachment fitting of the shock absorber; D - attachment fitting of the rear strut to the forward strut; E - attachment fitting of the semiaxle to the forward strut: 1 - valve grease cup; 2 - upper eye of strut; 3 - race; 4 - spherical sleeve bearing; 5 - universal joint; 6 - eye of strut; 7 - valve grease cup; 8 - universal joint; 9 - valve grease cup; 10 - shock absorber fork; 11 - rear strut fork; 12 - eye of forward strut; 13 - race; 14 - spherical sleeve bearing; 15 - eyes of semiaxle; 16 - rack of strut; 17 - hollow bolt.

landing gear strut with a spherical bearing. The constructions of the bearings of the lower and upper fittings are analogous. The front eyelet serves for towing the aircraft.

On the ends of the strut there are openings for a hose, which brings compressed air to the wheel brakes and skis or to the float controls.

The rear strut is made of the same material as the front, has constant drop-shaped section along the length and is welded along the trailing edge. The strut terminates at the top with an eye, entering the forked end of the universal joint, and at the bottom - with a bracket, which covers the lower ball-and-socket joint of the eye of the forward strut.

The struts after welding are quenched and primed with ALG-5 primer.

Semiaxle

Semiaxle - hollow; is made from a one-piece steel forging and has the shape of an elbow, bent at an obtuse angle. The semiaxle with the short end, on which there is a reinforcing flange, is pressed with force fit on the shock absorber cylinder to the stop at its external flange. The semiaxle is kept from turning by a tapered bolt, passing through the holes of the semiaxle and the eyes of the cylinder.

For coupling with the rack of the forward strut the semiaxle has eyelets. Under the eyelets in the semiaxle there is an opening for passage of the hose, which supplies compressed air to the outer wheel brake through the internal cavity of the semiaxle. On the extended (horizontal) part of the semiaxle there are splines for fitting two brake flanges, two bands under the inner races of tapered roller bearings, male thread under the wheel attachment nut and female thread for attaching the fairing of the wheel hub, on the frontal area - cutouts for exit of the brake hose.

On aircraft from the 64 series there are installed reinforced semiaxles Sh4101-93 instead of semiaxles Sh4101-90 (Fig. 49).

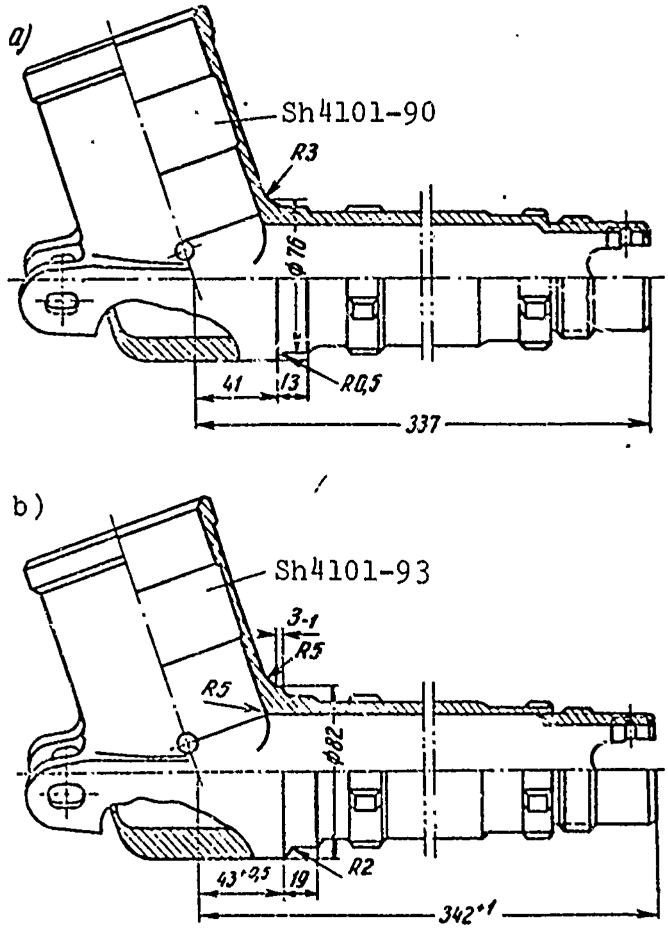
a)
Sh4101-90
R3
⌀76
41
13
R0,5
337
b)
Sh4101-93
3-1
R5
R5
⌀82
43+0,5
19
R2
342+1

Fig. 49. Semiaxle: a) semiaxle on aircraft to the 63 series inclusively; b) semiaxle on aircraft from the 64 series (reinforced).

The semiaxles are reinforced due to the increase of diameter in the adapter of the semiaxle to the mouth by 6 mm and length - by 5 mm. Semiaxles have fillet transition of the large radius of the horizontal part of the semiaxle to the mouth and increased bearing surface of the brake flange.

In connection with the change in the dimensions of the semiaxle the plant in each set of skis adds Sh4300-7 thrust ring, and also two Sh4300-5 rings, which should be installed with installation of skis on aircraft up to the 19th aircraft of the 63 series.

On the bolt which connects the rack of the forward strut with the eyelets of the semiaxle there is installed a link with a ball seat under a special jack for removal of the landing gear wheels, which is attached to a single set of the aircraft.

During operation on the An-2 aircraft there were observed cases of failure of the connection bolts of semiaxles of the landing gear to the forward strut. In most cases the bolts fail on the radial openings for the issue of lubricant to the top surface. The defect is easily revealed by the visual inspection of the connection of struts to the landing gear semiaxle during the displacement of parts of the destroyed bolt forward or back, loosening of the nut or loss of part of the bolt.

The reason for the failure of bolts is their insufficient strength and homogeneity of material of the rubbing pair.

In connection with these deficiencies on aircraft of the 101 series for improvement of the operating conditions and lubrication the manufacturer pressed bronze sleeves into the eyes of the landing gear semiaxle and from the 115 series replaced the attachment bolts of the strut by reinforced Sh4100-69, having less depth and smaller diameter of axial lubricating holes.

These measures decreased the cases of failure of the connection of the forward strut to the landing gear semiaxle. There were individual cases of the failure of Sh4100-69 bolts, connected with rough landings of the aircraft, the incompetent operation of the An-2 aircraft on skis, and also by the breakdown of the technology of manufacture of Sh4100-69 bolts in repair plants.

During maintenance it is necessary to thoroughly inspect the Sh4100-69 bolts, to check if there is weakening of their nuts or loss of part of the bolt due to its failure, and at the proper time to qualitatively pack lubricant into the joints of the forward struts and semiaxles of the landing gear.

During operation there were cases of breakage of the semiaxle in the fillet transition. This defect appears, mainly, during the winter period of operation of aircraft as a result of the sharp and tight turns when taxiing on airfields with unsmoothed snow cover, and also from moving aircraft on the ground with frozen ("not unstuck") skis.

Flying and technical personnel must strictly follow the Manual through summer and winter operation of the An-2 aircraft.

Shock Absorber

The landing gear shock absorber (Fig. 50) consists of a cylinder, a rod moving in it, rod end with a filling tube, cup packing, valve nut, diffuser with valve, rubber seal of filling tube in the wall of the rod, charge valve for charging the shock strut with nitrogen or air and two bronze rod guides in the cylinder.

The cylinder is made from a Chromansil steel pig by drilling out and boring. At the bottom the cylinder has two eyes for

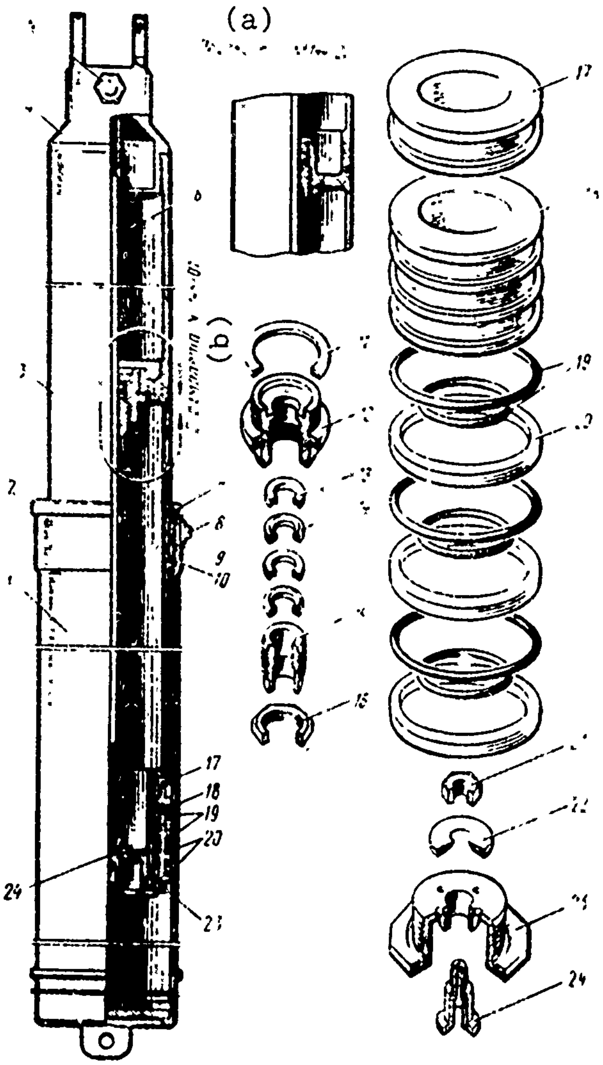

Fig. 50. Landing gear shock absorber: 1 - cylinder; 2 - upper sleeve; 3 - rod; 4 - rod base; 5 - charging valve; 6 - filling tube; 7 - felt ring; 8 - screw; 9 - groove for graphite lubrication; 10, 11 - fiber gasket; 12 - nut; 13 - rubber seal; 14 - shaped washer; 15 - guide bush; 16 - lock nut; 13 - rubber seal; 14 - shaped washer; 15 - guide bush; 16 - lock nut; 17 - duralumin spacing ring; 18 - lower bronze sleeve; 19 - rubber ring; 20 - leather ring; 21 - attachment nut of valve washer; 22 - duralumin valve washer; 23 - valve nut; 24 - hollow valve (diffuser) bolt.

KEY: (a) To aircraft No. 144-20; (b) From aircraft No. 145-01.

attaching the cylinder of the shock strut to the semiaxle with a conical bolt. Inside the cylinder, at its top, there is a thread under a bronze nut (upper sleeve) and two openings under the locking screws of the bronze nut.

The internal working surface of the cylinder is honed, the external - is ground and is coated with a layer of cadmium, except the bottom section, on which the semiaxle is pressed.

The cylinder after manufacture is tested for strength under pressure 250 kgf/cm^2 with the application of engine lubricating oil.

At the bottom on the cylinder there is soldered a label with the specifications of the shock absorber. The cylinder is made from 30KhGSA steel and hardened.

The rod of the shock absorber is hollow, is made from a Chromansil steel pig by drilling out and boring. At the top the rod has female thread for connection with the end of the rod (base). At the bottom the rod finishes in a transition section under a sealing packet with female thread under the nut of the valve and cutouts at the end for locking the valve nut with screws.

On the external surface of the rod there is a limiting flange for limitation of the stroke of the rod in the cylinder. The limiting flange rests in the bronze nut and thereby prevents disengagement of the rod from the cylinder during flight with release of the shock absorber from load.

Inside the rod, in its middle, there is a wall with an opening, through which passes the charge tube of the end of the rod. The wall divides the inner cavity of the rod into two chambers: upper - nonworking and lower - working, where compressed nitrogen or air is located.

The external surface of part of the rod (above the limiting flange), which goes in a bronze nut, is chrome-plated and polished.

On the surface area of the rod with an electric pencil there are applied graduation marks with figures 42, 90, 117, 135, 148, 160 and 170, showing the settling of the shock absorber in millimeters on the flight line, and top figure 245, showing the full stroke of the rod in the cylinder in millimeters.

The graduation mark with the figure 42 is a check, intended for checking the quantity of AMG-10 oil, necessary for charging the shock absorber. The required quantity of AMG-10 oil for filling the shock strut is 1680 cm^3. The initial nitrogen (air) pressure is 30-1 kgf/cm^2.

The rod is made from 30KhGSA steel and hardened. The head of the rod is made from a Chromansil steel forging by drilling out and milling. The head has two eyes for attaching the shock absorber to the fittings of the wing center section truss, and male thread for connection of the head to the upper part of the rod, opening with thread under the charge valve, tube, to which the filling tube is welded, and the check hole for checking the seal of the rubber seal of the filling tube in the wall of the rod.

The threads of the head and rod are tin-plated and screwed together (connected) in heated state to get a tight coupling (junction) with the thread.

On the lower end of the rod is assembled the sealing packet, which consists of a duralumin spacing ring, lower bronze sleeve with external and inner grooves under rubber sealing rings, three external rubber rings, three leather spacing rings, protecting the rubber rings from their closing between the cylinder and bronze sleeve during operation of the shock absorber, and three inner rubber rings, sealing the rod with the sleeve. The lower bronze guard of the rod in the cylinder and the entire sealing packet are tightened by the valve nut, screwed on the thread into the end of the rod.

On aircraft up to the 124 series on the rod there was installed a sealing packet with leather cups, and as fluid for the landing gear and tail wheel shock absorbers there was used an alcohol-glycerin mixture. On aircraft from the 124 series for preventing the appearance of corrosion and unification of fluid the alcohol-glycerin mixture has been replaced by AMG-10 mineral oil.

The valve nut consists of a steel housing with thread and diffuser with duralumin valve washer. In the housing of the nut there are located central opening under the hollow bolt of the diffuser, four end openings 5.5 mm in diameter for overflow of the fluid from the cylinder into the working cavity of the rod and two openings in the head of the nut under the set screws.

For screwing the valve nut into the rod the housing of the nut has faces under the wrench. A hollow bolt with axial opening 2.8 mm in diameter is inserted into the central opening of the valve nut and can move upward and downward in it. The movement of the bolt in the opening of the nut is limited upward by its head, and down - valve washer made of aluminum alloy, which is secured by a nut in the conical section of the diffuser bolt. With motion of the bolt upward the valve washer opens four holes in the housing of the valve nut, during motion down - covers them.

The valve nut is locked with two screws, screwed into the body of the nut head. The cylindrical smooth ends of the screws enter the splines cut in the end of the rod of the shock absorber. The screws are saftied with wire.

For sealing the point of passage of the filling tube into the wall of the rod there is mounted a packet of rubber seals and duralumin shaped rings. On aircraft from the 145 series the filling tube in the rod, the packet of seals and shaped rings are made removable (Fig. 50).

The motion of the rod inside the cylinder is guided by two bronze guides (sleeves), a nut and bushing. In the body of the nut are bored two ring grooves, of which the lower serves for packing ST graphite lubrication, and the upper - for felt padding , which removes dust and dirt from the rod with settling of the shock absorber. Under the nut there is placed an annular fiber gasket, into which with the reverse stroke of the shock absorber the rod rests on his flange; the nut is locked with two screws.

The charge valve (Fig. 51) serves for charging the shock absorber with air. The valve consists of a housing, a rod with rubber sealing cone, spring, two nuts and valve bonnets with cone.

The sealing of the air chamber of the rod before assembly of the shock absorber is tested for strength under pressure 250 kgf/cm^2 and for airtightness - at atmospheric pressure equal to 150 kgf/cm^2. Endurance under pressure - 2 min.

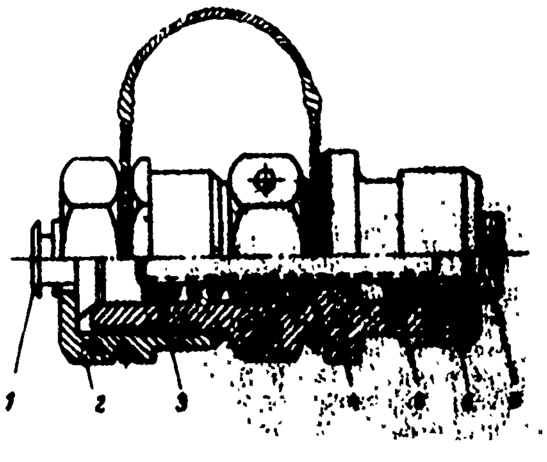

Fig. 51. Charge valve: 1 - cover plug; 2 - valve bonnet; 3 - nut; 4 - valve body; 5 - sealing cone (valve); 6 - rod.

Charging of landing gear shock absorber with AMG-10 oil and nitrogen (air). For filling the landing gear shock absorbers there is used AMG-10 oil (GOST 6794-53). The shock absorbers are charged with nitrogen.

Note. When there is no nitrogen, it is permitted to recharge the shock absorbers with air.

In connection with the filling of shock absorbers with AMG-10 oil instead of alcohol-glycerin mixture AM70/10 the following are introduced into the construction of the shock absorber:

1) in the sealing packet of the rod instead of leather cups there are used rubber rings;

2) the filling tube of the rod is shortened;

3) on the surface area of the rod there is applied a graduation mark, intended for checking the quantity of oil necessary for charging the shock absorber.

The charging of shock absorbers with AMG-10 oil has features, which ensue from the ability of AMG-10, being under pressure, to dissolve air, which is accompanied by some pressure drop. Thus, if after parking the aircraft on the ground we free the shock absorbers from load and measure the pressure, then it will prove to be less than initial by approximately 1 kgf/cm^2. In 1-1.5 h the pressure is restored.

With pressure release to "0" there occurs separation of the foam above the oil from the oil. The process of formation of foam lasts 1.5 h. Foam is also formed when pouring AMG-10 oil into the shock absorber through the filling tube. In this case in the tube air locks can be formed, especially in the landing gear shock absorbers, where the tube has long length and small passage area.

Proceeding from this the check of pressure and the quantity of oil in the shock absorbers under operating conditions must be accomplished in the following order:

1. Raise the aircraft on the side of the shock absorber to be checked with a screw jack so that the wheel does not touch the ground. Hold in such position 1 h.

2. Having removed the cap from the filling valve, with device $\frac{63\,740}{0{,}28}$ measure the pressure in the shock absorber and charge the shock absorber with nitrogen (air) if the pressure is less than the lower limit. During charging use the Λ5802-1 hose together with the device $\frac{63\,740}{0{,}28}$.

3. If there are signs of oil leakage from the shock absorber, unscrew the charge valve and hold the shock absorber for 1 h in free state, which is necessary for the disappearance of foam. Then gradually lower the jack until the wheel touches the ground and further, until the shock absorber is compressed to check mark 42. With normal charging the oil should rise to the level of the seat for the charge valve. Otherwise it is necessary to add oil until its visible level in the filling tube stops going down. If the quantity of oil is greater than normal, the excess is drained. The filling of oil should be performed intermittently, with a thin stream to prevent the formation of air locks in the charge tube.

4. Upon completion of the check raise the aircraft a second time with the jack until the wheel leaves the ground, set the charge valve and charge the shock absorber with nitrogen. Replace the cap of the charge valve and seal it.

Lower the aircraft with the jack.

During the operation of An-2 aircraft there were observed cases of leak of AMG-10 from the check hole of the shock absorber because of the poor quality of sealing collars. For removal of this defect the manufacturer has increased the thickness of rubber rings and introduced packing of TsIATIM-201 lubricant into the cavity between the cylinder and rod above the sleeve, and no check hole is made in the cylinder of the shock absorber.

It is possible to judge the correctness of charging of the shock absorbers by the amount of their settling with the aircraft at rest on the ground. The relationship of settling of the shock absorber to the change in the aircraft weight is given in Table 10 (on aircraft of series 124-01)

Table 10.

(1) Вес самолета, кг	Осадка, мм (2)
3600	90±9
4200	117±12
4800	135±14
5250	148±15
5500	170

KEY: (1) Aircraft weight, kg;
(2) Settling, mm.

At normal pressure of nitrogen and small settling of the shock absorber part of the fluid must be removed from the shock absorber. During removal of fluid raise the aircraft on lifts and relieve the air pressure to zero.

At normal air pressure and large settling of the shock absorbers it is necessary to add fluid to the necessary volume to the shock absorber.

Shock absorber fairings. The landing gear shock absorbers are enclosed by fairings made of duralumin. The fairing consists of two flaps (outer and inner), assembled along the leading edge on a ramrod and along the trailing edge - on four "Dzus" type screw fasteners. With loosening of the fasteners the inner flap can be opened.

The fairing at its top is fastened to the rod with two bands. Inside to the flaps of the fairing are riveted four guide profiles, along which slides the band, rigidly mounted at the top of the cylinder, with its textolite cover plates.

For checking the settling of the shock absorber by the marks of the rod on the outside of the fairing there is a folding cover, which is shut by two retaining springs.

For convenience of access to the charge valve of the shock strut in the fairing of the joint of the wing center section pyramid there is an easily removable cover, mounted on retaining springs.

During operation there are cases of the moving of the Sh4102-3 ramrod of the fairings of the shock struts upward from impact loads, due to which the folds of the fairings are deformed, hinges work out, cracks appear. For removal of the indicated defect at operational aircraft concerns with 300-hour maintenance regulations, and at repair enterprises during successive repairs of the An-2 aircraft there is performed modification of the fairings of shock struts according to the instruction of the Ministry of Civil Aviation of the USSR.

Operation of shock absorber. With impact against the ground the cylinder of the shock absorber is moved upward along the rod (Fig. 52). The fluid, having raised the washer of the diffuser, overflows from the cylinder into the air chamber of the rod through four holes in the nut 5.5 mm in diameter, hole in a hollow bolt 2.8 mm in diameter and compresses the air in the working chamber of the rod.

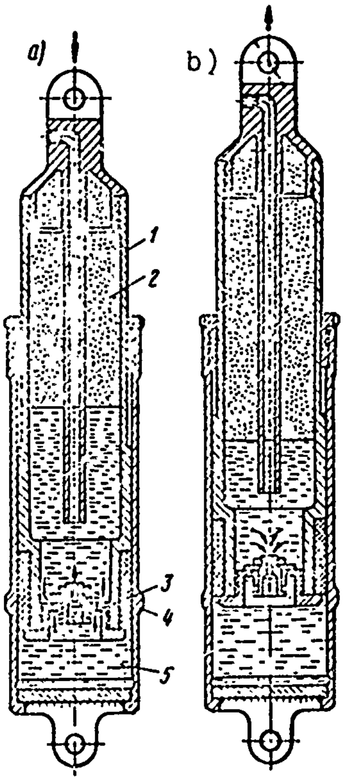

Fig. 52. Diagram of operation of the landing gear shock absorber: a) forward stroke; b) return stroke; 1 - rod; 2 - compressed air; 3 - valve nut; 4 - cylinder; 5 - fluid.

With removal of the load from the shock absorber the fluid under air pressure presses the valve nut of the diffuser, the valve covers the four holes in the nut 5.5 mm in diameter and the fluid overflows back into the cylinder through only one hole in the hollow bolt 2.8 mm in diameter, which provides smooth expansion of the shock absorber, i.e., reverse shock absorption occurs.

Landing Gear Wheel

The landing gear wheel (Fig. 53) is semi-balloon type with two-sided pneumatic expander-tube brakes and multilayer self-sealing casings. The wheel drum and detachable flange are cast from Elektron. The drum has one permanent flange and hub, in the journal of which there are pressed the outer races of roller bearings.

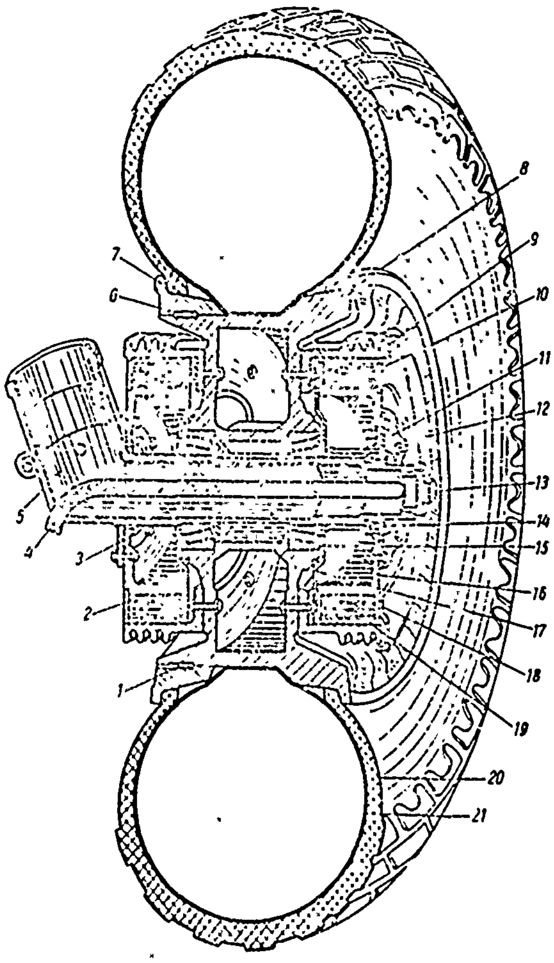

Fig. 53. Landing gear wheel: 1 - lock pin; 2 - brake chamber; 3 - detachable inner brake flange of the semiaxle; 4 - brake hose; 5 - semiaxle; 6 - locking half-ring; 7 - detachable flange; 8 - wheel drum; 9 - brake jacket; 10 - recoil spring; 11 - detachable brake flange of semiaxle; 12 - wheel fairing; 13 - fairing nut; 14 - adjusting nut; 15 - roller bearing; 16 - brake housing; 17 - obturator; 18 - detachable side of brake housing; 19 - friction plate; 20 - tire casing; 21 - tire tube.

The detachable flange is fastened on the wheel drum with two half-rings for preventing axial shift of the flange and six pins - for preventing radial displacement.

On both sides to the wheel drum are fastened steel brake jackets, each to nine bolts. On the housing of the jacket there are ribs for heat removal, appearing with braking of wheels, into the surrounding air. Inside the brake jackets enter the pneumatic multi-shoe expander-tube brakes.

The housing of the brake has the shape of a drum with two sides. One of the sides is detachable and is fastened to the housing with bolts. Between the sides along the circumference there are arranged 15 friction brake shoes, pressed to the housing by two spiral springs.

Each shoe is a frame, to which a friction plate made of KF-3 plastic is attached with four rivets. The shoes are kept from turning by splined protrusions on both sides of the brake housing, which enter the splined grooves of the shoes.

Under the action of compressed air, which is supplied from the brake control system, the chamber is expanded and presses the brake shoes to the brake jacket. With pressure drop in the brakes the shoes depart from the brake jacket under the action of two spiral recoil springs.

To the brake housing on eight bolts there is fastened a steel flange, which is mounted on the semiaxle with the aid of a spline joint.

The wheel is mounted on the semiaxle on two No. 9-7513 radial thrust tapered roller bearings, which are pressed into the hubs of the wheel drum.

The axial and radial play of the wheel is removed by tightening the nut.

The inner brake has a safety shield attached to the side of the housing.

The external brake is enclosed by a fairing, which is fastened on the end of the semiaxle with a nut.

During operation it is necessary to replace the wheel if the following defects are detected:

1) cracks of any length in the ring groove of the drum under the locking half-rings of the detachable flange and longitudinal scratches on the surface of the groove with depth more than 0.5 mm;

2) grooves are developed under the locking half-rings, the size from the edge of the groove to the end of the drum housing becomes less than 9 mm;

3) dents in the wheel housing with depth more than 5 mm;

4) weakening of the fit of the external races of roller bearings;

5) cracks in the housing of the wheel and brake jackets;

6) the presence of conical or uneven wear of the effective surfaces;

7) low spots with depth more than 0.5 mm and the presence of temper colors on the working surfaces of the brake jackets.

It is necessary to check the presence of fatigue cracks on the surface of the groove under the locking half-rings by the paint method.

For revealing the above-mentioned defects and other damages of the brake mechanisms when performing aviation and chemical operations as well as during training flights on aircraft with wheel-type landing gear it is necessary to remove the wheels from the semiaxles every 100 h of aircraft flight.

Before installation of wheels it is necessary to grease the roller bearings with UTV (1/13) or St (NK-50) lubricant so that the space between the rollers and the inner races of roller bearings of the wheel would be filled up. Regulate the tightening of the wheel roller bearings by the adjusting nut. Tightening the roller bearings of the wheel when mounting it on the semiaxle of the landing gear should provide free rotation of the wheel by hand and the absence of axial and radial play.

The adjusting nut of the wheel must be saftied with PVK or KOK safety wire.

After installation of the wheel it is necessary to apply a red mark 25-30 mm wide to the flange and to the top part of the wheel cover with nitrolacquer.

§ 10. TAIL WHEEL INSTALLATION

The tail wheel installation (Fig. 54) consists of a rocking truss, cylinder of fork with centering mechanism, fork, brakeless wheel and shock absorber.

The welded rocking truss consists of a cylinder, fork with eyes for attachment to the fuselage fittings and two tubes with eyes, into which a race with spherical bearing is pressed.

Into the top and bottom of the cylinder of the truss are pressed bronze bushings. In the bushings is mounted the cylinder of the wheel fork. To the top of the cylinder of the fork there is welded a washer with an opening for passage of the bolt of the centering mechanism, and to the bottom are mounted and welded the heel and cam. The cam of the fork cylinder fits closely to the bottom of the truss cylinder, machined to the cam profile. To the heel of the fork cylinder with four bolts there is bolted the wheel fork, stamped from AK6 alloy.

The centering mechanism, or the spring-cam device consists of cams, spring and coupling bolt with washers, mounted inside the fork cylinder. The spring-cam device allows the wheel to turn 360° together with the fork and fork cylinder and with deflection of the wheel to an angle less than 90° forcedly returns it to the neutral position.

With neutral position of the wheel (the wheel is in the line of the longitudinal axis of the aircraft) the fork cylinder is pulled upward by the spring and its cams and the cams of the truss cylinder across the entire surface fit closely to one another. With lateral loads on the wheel the cylinder of the fork is turned, cams force it to drop and compress the spring. For decrease of friction the cam surface of the truss cylinder is copper-plated. For provision of lubrication of the fork cylinder and bronze sliding bearings on the truss there are valve grease cups; the upper grease cup has a connection.

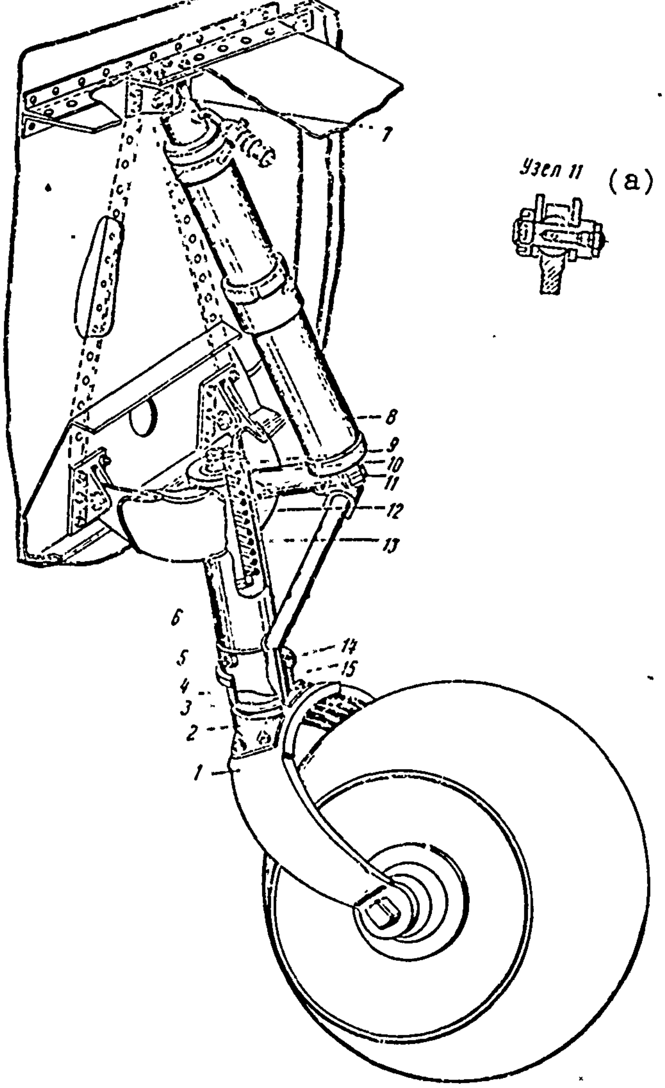

Fig. 54. Tail wheel installation: 1 – wheel fork; 2 – heel of pivot (cylinder of fork); 3 – cam of pivot; 4 – housing; 5 – valve grease fitting; 6 – rocking truss; 7 – ball-and-socket joint of shock absorber; 8 – shock absorber; 9 – washer of pivot (cylinder of fork); 10 – upper bronze bushing of pivot; 11 – ball-and-socket hinge of truss; 12 – spring; 13 – pivot (cylinder of fork); 14 – ring; 15 – lower bronze bushing of pivot.

KEY: (a) Joint 11.

For the purpose of preventing dust and dirt from getting on the friction surfaces of cams on the truss there is a housing with a felt ring.

The truss and cylinder of the fork are made from Chromansil steel.

Tail wheel (Fig. 55) – balloon type, brakeless. The wheel drum is cast from Elektron, has detachable flange, which is fastened to the drum with two half-rings and pins.

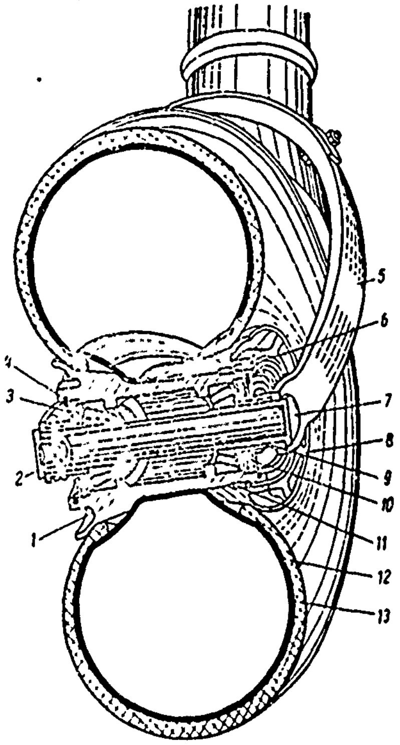

Fig. 55. Tail wheel: 1 – wheel drum; 2 – wheel axle nut; 3 – ring; 4 – split locking half-ring; 5 – wheel fork; 6 – locking half-ring; 7 – wheel axle; 8 – removable flange; 9 – spacer; 10 – roller bearing; 11 – lock pin; 12 – tire casing; 13 – inner tube.

For increase in the adhesion of the casing with the bead rim of the drum on the flanges there are splined grooves, which enter the splined protrusions of the bead of the cover. In the hub of the drum on both sides there are pressed tapered roller bearings. The oil seals of the bearings consist of a felt ring, enclosed between two duralumin washers. The oil seal is locked with a split locking ring.

The wheel is mounted in the fork on a steel hollow axle, between two spacers, and it is clamped by a castle nut, which is screwed inside the axle. The axial and radial plays of the wheel are removed by tightening the nut. The nut is locked with a cotter pin through the spacer.

Shock absorber of the tail wheel installation (Fig. 56) in its construction is similar to the landing gear shock absorber.

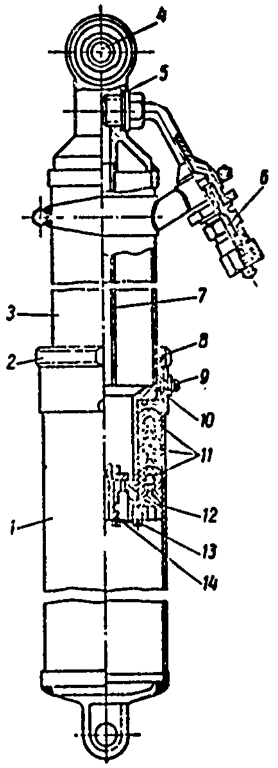

Fig. 56. Shock absorber of the tail wheel installation: 1 – cylinder; 2 – upper sleeve; 3 – rod; 4 – ball joint; 5 – gasket; 6 – charge valve; 7 – filling tube; 8 – felt ring; 9 – screw; 10 – groove for graphite lubrication; 11 – rod packing on aircraft up to the 124 series; 12 – valve nut; 13 – counterpin; 14 – hollow bolt of valve (diffuser).

Figure 57 shows the packing of the shock absorber of the tail wheel on aircraft from the 124 series. In connection with the variation in packing, into the construction of the shock absorber there are also introduced the appropriate changes:

1) the thread diameter is increased from 64 × 1.5 to 66 × 1.5 on the shock absorber cylinder as well as on its upper sleeve;

2) on the external surface of the rod there is applied a graduation mark with the number 33, intended for checking the quantity of oil necessary for charging the shock absorber;

3) the filling tube is shortened.

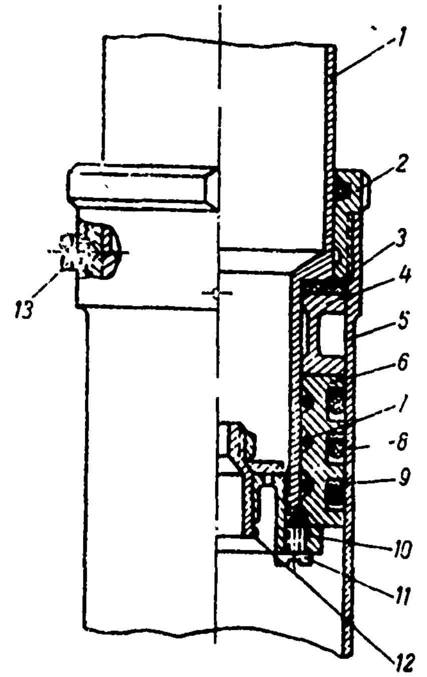

Fig. 57. Rod packing of the tail wheel shock absorber on aircraft from the 124 series: 1 – rod; 2 – upper bronze sleeve (nut); 3 – fiber packing; 4 – duralumin spacing ring; 5 – cylinder; 6 – lower bronze sleeve; 7, 8 – rubber ring; 9 – leather ring; 10 – nut valve; 11 – counterpin; 12 – hollow bolt of valve (diffuser); 13 – counterpin.

The full stroke of the rod in the shock absorber cylinder is 120 mm. Parking settling of the shock absorber at normal gross weight of the aircraft is 65 ± 10 mm. For charging the shock absorber 440 cm^3 AMG-10 oil is required.

Charging of the shock absorber with fluid and air is similar to charging the landing gear shock absorber. The air pressure in the shock absorber, free from load, is 25 ± 1 kgf/cm^2. For charging the shock absorber with air and checking the pressure it is recommended to use a hose and attachment, entering the set of ground equipment of the aircraft, being supplied by the plant.

The rocking truss is fastened by its eyes to the bottom joints of frame No. 23. The landing gear shock absorber is fastened to the joint on frame No. 23 and to the tubular strut of the truss cylinder.

For inspection of the truss and shock absorber of the tail installation on the right side of the fuselage between frames Nos. 23 and 24 there is a hatch. During inspection of the shock absorber pay special attention to the absence of dislodging of fluid from the check hole of the shock absorber cylinder as well as to settling of the shock absorber, and also to the absence of cracks in joints and eyes and the shear of clamping bolts of joints to the frame.

On An-2 aircraft of Polish People's Republic [PNR] (ПНР) production the tail wheel installation (Fig. 58) is distinguished constructively from the tail wheel installation described above. It consists of a yoke, shock absorber, wheel with fork, centering device and locking mechanism.

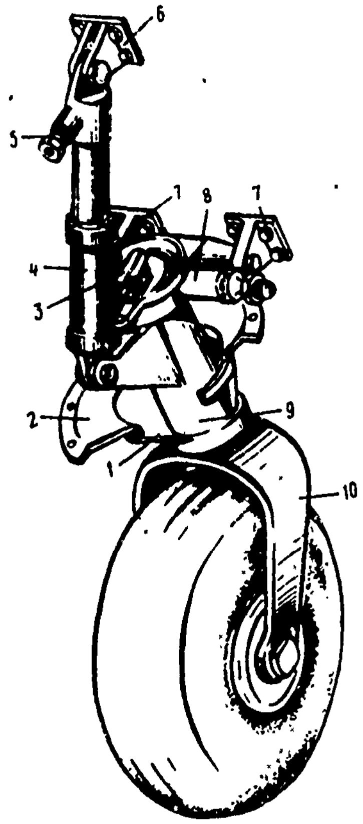

Fig. 58. Tail wheel installation on aircraft of PNR production: 1 – rubber cover; 2 – fairing; 3 – centering device; 4 – shock absorber; 5 – charge valve; 6 – upper bracket; 7 – lower brackets; 8 – locking mechanism; 9 – yoke; 10 – wheel fork.

The yoke (Fig. 59) is made by stamping from AK6 aluminum alloy and is a cylinder with two forks: the front with bronze bushings pressed into it for coupling to the fuselage on the joints at frame No. 23 and the rear – for attachment of the eye of the shock absorber cylinder. On top and underneath to the yoke are pressed the bronze sleeves, which the barrel of the wheel fork, stamped out of AK6, enters. On top on the yoke with three bolts there is attached the cam of the centering device. The fork is kept from falling from the yoke by a cover, attached with four pins. The pins are fixed by a clip, which is fastened to the cover with screws. On the cover there are eyes for attaching the lever with roller.

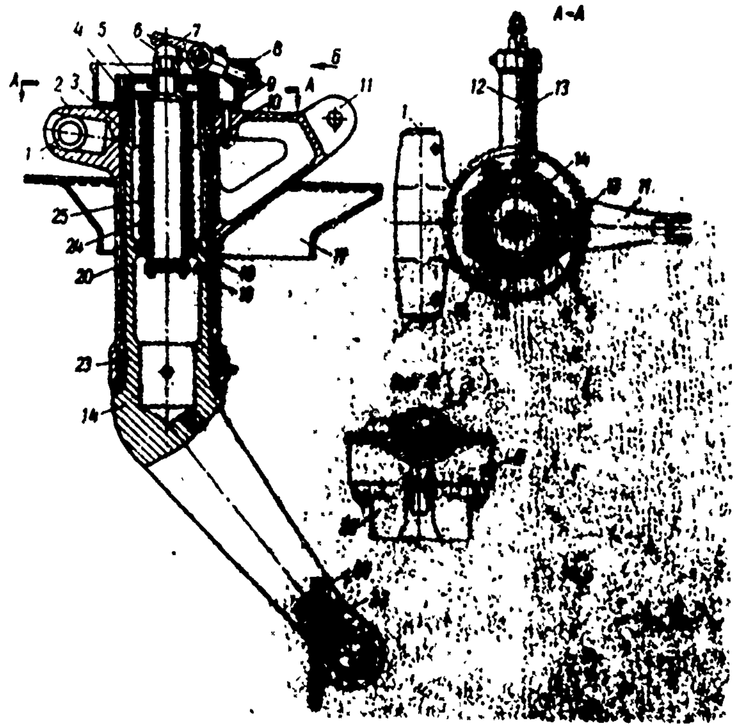

Fig. 59. Yoke and fork of the tail wheel installation: 1 – bushing; 2 – front fork; 3 – bushing; 4 – race; 5 – cover; 6 – rod end; 7 – actuating arm of the centering device; 8 – roller; 9 – cam of the centering device; 10 – bolt; 11 – rear fork; 12 – rod of locking mechanism; 13 – cylinder; 14 – fork; 15 – pin; 16 – screw; 17 – fairing; 18 – bearing disk; 19 – roller; 20 – yoke; 21 – grounding cable; 22 – cover plate; 23 – bushing; 24 – spring; 25 – rod.

KEY: (a) View Б.

Inside the fork barrel there is installed a rod with a bearing disk and spring. On the rod end rests the lever.

During operation of the new tail wheel installation the following defects have been detected:

a) cracks in the yoke between the cylinder and the front fork bracket;

b) separation of the rear fork from the yoke cylinder;

c) with damage of the wheel fork or its corrosion it is necessary to change the fork together with the cylindrical part.

Operation of the centering device. With the neutral position of fork, when the wheel is located in the line of flight, the end of the lever with roller under the action of spring and rod is placed in the recess of the cam.

With lateral wheel loads the fork together with the cover and lever turns, forcing the roller to rise along the cam profile. The other end of the lever moves the rod downward and compresses the spring. With the disappearance of side load the roller of the lever under spring action is rolled into the recess of the cam, thereby returning the fork to neutral position.

With deflection of the wheel to 30-35° angle the spring-cam device returns it to the neutral position, i.e., centers the wheel to the line of flight.

The spring-cam device makes it possible for the fork together with wheel to turn 360°.

The locking mechanism is a cylinder with rod and recoil spring, installed on a thread to the right into the cam seat.

Under the action of compressed air, fed into the cylinder, the rod is advanced, compressing the spring, enters the opening of the cover and fork and locks the fork in the neutral position.

With air pressure drop in the cylinder the spring returns the rod to the initial position, unlocking the wheel fork.

The shock absorber of the tail wheel installation (Fig. 60) consists of cylinder, rod, diaphragm, valve nut, upper bushing, lower bushing, filling tube and charge valve for charging the shock absorber with nitrogen or air.

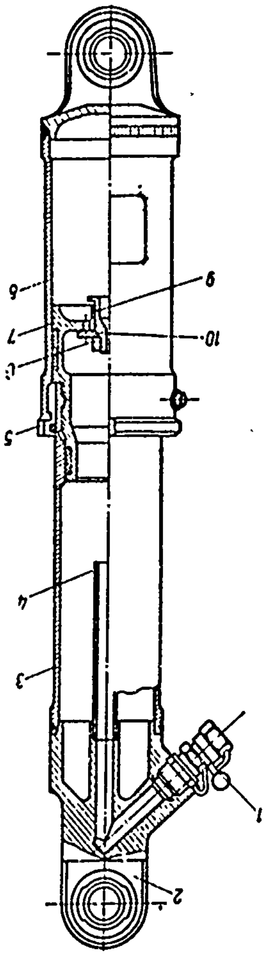

Fig. 60. Shock absorber of tail wheel installation: 1 – charge valve; 2 – eye; 3 – rod; 4 – filling tube; 5 – upper bushing; 6 – valve nut; 7 – lower bushing; 8 – cylinder of shock absorber; 9 – hollow bolt of valve (diffuser); 10 – valve washer.

Basic technical data of shock absorber

Full stroke of rod in the shock absorber cylinder, mm	125
Fluid used for charging the shock absorber	mineral soap AMG-10
Quantity of oil for charging the shock absorber, cm^3	440 ± 10
Initial nitrogen pressure, at	25 + 2
Shock absorber strength test, at	
by hydraulic pressure	160
for air pressure seal	140
Guaranteed conditions:	
trouble-free operation for 2000 takeoffs and landings	for 2 years

§ 11. LANDING GEAR SKIS

The landing gear skis of An-2 aircraft (Fig. 61a) are all-metal, of riveted construction and are made from D16 duralumin. The basic ski consists of a stressed frame, upper covering and runner.

Stressed frame (Fig. 61b) consists of cabane, 2 spars, 10 frames, front cast shoes, rear and side rims.

The spars are riveted from pressed duralumin angles and webs of sheet duralumin 2 mm thick.

The frames are stamped from duralumin plates. The middle parts of frames between spars are made 1.5 mm thick and the extreme outside-the-spar parts, — 2 mm thick.

The cast shoes are made from AL4 alloy, rear and side rims — from sheet duralumin 2 mm thick.

The cabane is welded from Chromansil tubes, is covered on top with an easily removable duralumin fairing.

The ski runner is made from duralumin sheet 3.5 mm thick edged on the face with EI-100 sheet stainless steel 0.6 mm thick by means of countersunk steel rivets.

The top covering is made from duralumin sheet 1 mm thick and is fastened to the frame with rivets and screws.

For reducing the ground-run distance when landing and for improvement of the maneuverability of the aircraft on snowy cover the skis are equipped with brakes.

The brake gear (see Fig. 61c) is placed in the aft compartment of the ski and consists of actuating air cylinder, two recoil springs and a rack with seven pins, protruding from the runner when braking to a depth of 45 mm. Brake control of skis is similar to brake control of the landing gear wheels. Pressure in the PU-7 reducing valve for the ski brakes is adjusted to 8-10 kgf/cm^2.

The ski is installed on the semiaxle of the landing gear. In connection with the change in the dimensions of the semiaxle on aircraft from the 64 series to the set of skis there is added thrust ring Sh4300-7. To each set of skis the plant adds two Sh4300-5 rings, which should be installed when mounting the skis on aircraft from the 19th machine of the 63rd series.

Tail ski (Fig. 62) is of all-metal construction. The ski consists of stressed frame, runner and removable upper covering.

The stressed frame consists of two spars and six transverse frames. Spars are made from duralumin pressed angles and duralumin web 1.5 mm thick. Frames are stamped from sheet duralumin 1.5 mm thick. The upper covering is made from duralumin sheet 1 mm thick and is bolted to the frame.

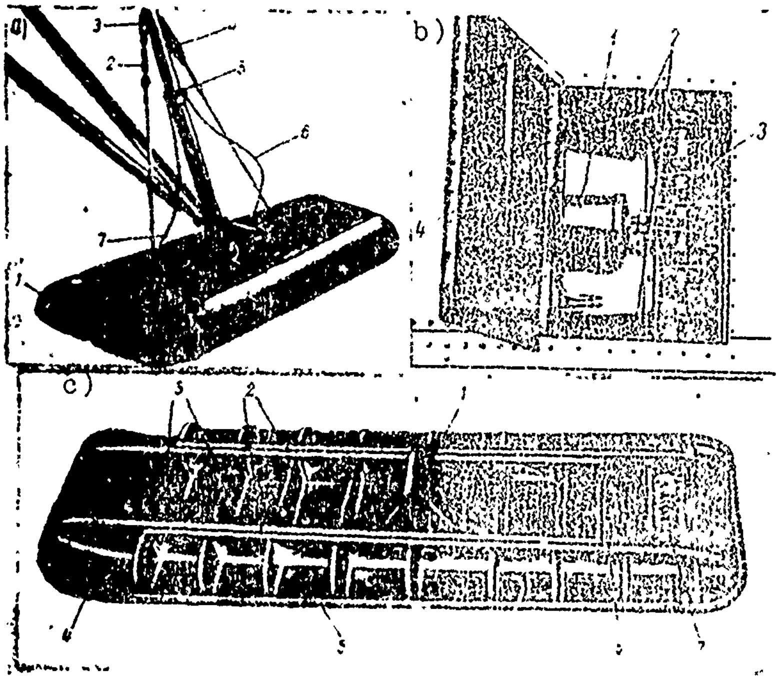

Fig. 61. Landing gear ski: a) overall view of ski landing gear: 1 – reinforced leading edge of the basic ski; 2 – front balancing chain; 3 – attachment yoke of shock absorbers; 4 – rear balancing chain; 5 – attachment yoke of safety cables; 6 – rear safety cable; 7 – front safety cable; b) brake gear: 1 – actuating air cylinder; 2 – recoil springs; 3 – rack with pins; 4 – hatch cover; c) frame of landing gear ski: 1 – cabane; 2 – spars; 3 – frames; 4 – runner; 5 – side rim; 6 – attachment point of actuating air cylinder; 7 – rack with washers.

Fig. 62. Tail ski: a) overall view of ski: 1 – tail ski; 2 – tail wheel fork; 3 – shock absorber of ski; b) frame of tail ski: 1 – spars, 2 – eye for attaching the spring shock absorber; 3 – [illegible]; 4 – frames.

The ski runner is made from duralumin sheet 3 mm thick, edged on the outside with sheet stainless steel 0.6 mm thick. For improvement in the longitudinal stability of the ski the runner is equipped at the aft end with a guide ridge, which facilitates the turning of the ski behind the aircraft when taxiing.

For mounting the ski to the wheel fork two milled duralumin cabanes are rivetted to the spars.

Or aircraft of the 26 series the wheel fork does not have eyes under the towing and steering arm for turning the wheel when towing the aircraft. With the installation of tail ski on aircraft up to the 26 series the fork requires finishing by means of removal of the eye under the towing and steering arm.

Installation of skis on the aircraft. During the transition to operation of the aircraft on ski landing gear it is necessary that the thickness of the snowy cover of the airfield be not less than 35 cm with freshly fallen snow and 25 cm with rolled or compacted snow.

With change-over of aircraft from wheels to skis first we install the landing gear skis and then the tail ski.

The landing gear ski angle relative to the longitudinal axis of the aircraft with it hanging is equal to 0°.

In flight each ski is kept in the set position by two balancing chains. Each balancing chain consists of a spring shock absorber, cable 8 mm thick and clamp for adjustment of the chain length. The spring shock absorber consists of a cylinder, rod and a set of disk springs. The stroke of the front spring shock absorber is 95-100 mm, rear 18-23 mm.

The upper ends of the balancing chains are fastened to a duralumin yoke, installed on the rod of the landing gear shock strut, the bottom ends are fastened to the ski. The free length of the front balancing chain is equal to 1520 mm, and rear – 1190 mm.

Safety cables are fastened with the upper end to the steel yoke installed at the top of the cylinder of the landing gear shock strut, and bottom ends – to the ski. Safety cables with suspension of the aircraft in the line of flight ensure deflection of the leading edge of the ski from neutral position down to 15° ± 30' and upward – to 7°30' ± 30'.

The suspension of the ski weighs 6 kg. The weight of the ski with suspension 89 kg.

During installation of the tail ski to the aircraft it is necessary to check that chocks are installed under the skis along the axis and the parking brake is actuated.

Raise the aft end of the aircraft on a lift and install the ski, having preliminarily greased the bronze bushings with UTV (1-13) lubricant. The ski angle relative to the longitudinal axis of the aircraft is equal to 1° ± 30'. The range of angular deflection of the ski along the vertical is within limits from +21° to -30°.

In flight the ski is held in the prescribed position by the spring shock absorber, which is fastened to the eye bolt of the tail installation fork as well as to the ski. The ski can be turned, as the wheel, 360°.

§ 12. PNEUMATIC SYSTEM

The pneumatic system on An-2 aircraft (Fig. 63) is intended for control of brakes of wheels, skis and agricultural equipment.

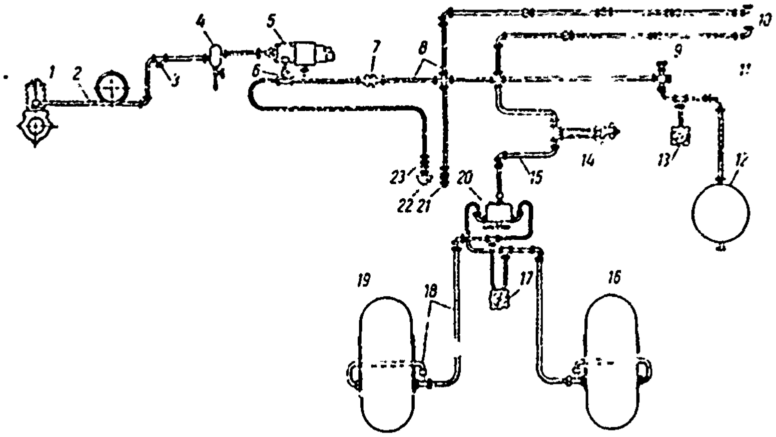

Fig. 63. Schematic diagram of pneumatic system from the 115 series: 1 – AK-50M compressor; 2 – line to compressor; 3 – plug; 4 – FT-9900 sump filter; 5 – AD-50 automatic pressure control; 6 – check valve; 7 – direct-flow filter; 8 – lines; 9 – KN-50 filling cock; 10 – recharging fitting of the tail wheel shock absorber; 11 – air feed fitting to PU-7 control of agricultural equipment; 12 – aircraft compressed air bottle; 13 – 80 kgf/cm^2 pressure gauge; 14 – reducing valve PU-7; 15 – hose; 16 – right landing gear wheel; 17 – two-pointer 12 kgf/cm^2 pressure gauge; 18 – hose; 19 – left landing gear wheel; 20 – PU-8/1 differential; 21 – recharging fitting of the landing gear shock absorbers; 22 – aircraft charge fitting; 23 – check valve.

The pneumatic system of the Ан-2 aircraft includes: AK-50M compressor, FT-9900 filter sump, AD-50 automatic pressure control, direct-flow filter, KN-50 filling cock with reducing valve, 80 kgf/cm^2 air pressure gauge, aircraft bottle, PU-7 reducing valve, PU-8/1 differential, two-pointer 12 kgf/cm^2 air pressure gauge of brake line, aircraft charge fitting and recharging fitting of shock absorbers and wheels under field conditions.

The aircraft bottle is charged with air on the ground from an airport bottle through the side charge fitting. During engine operation the charging of the bottle occurs from the compressor, installed on the engine. The pneumatic system allows recharging the shock absorbers and wheel chambers under field conditions, for which there are additional recharging fittings arranged one underneath the fuselage between frames Nos. 3 and 4 and the second – on the web of frame No. 23.

To the recharging fittings there is joined a hose with an attachment for checking the pressure. The hose has replaceable fittings, which allow recharging both from the aircraft and from the airport bottles.

Units of Pneumatic System

Compressor AK-50M – aircraft two-stage, continuous-running air cooling compressor at 50 kgf/cm^2. The compressor is mounted on the engine crankcase rear cover on the right side. The capacity of the compressor is 8 l of air with pressure 50 kgf/cm^2 for 22 min. The necessary flow-off velocity of the compressor cylinder with air is not less than 72 km/h.

Sump filter FT-9900 is located at the lowest point of the pneumatic system and is fastened to frame No. 3 of the fuselage under the cockpit floor near the bottom hatch. The drain of deposits from the sump filter is produced through the cock by the drainage tube. For draining the deposit it is necessary to turn the handwheel of the cock. In the closed position the handwheel is saftied with wire. During operation the deposit from the sump filter is drained during every postflight maintenance and servicing at a brief stop. Before takeoff it is necessary to check that the sump filter is closed and saftied.

Automatic pressure control AD-50 (Fig. 64) serves for maintaining constant pressure in the pneumatic system within 40-54 kgf/cm^2. The automatic control is installed on the left under the cockpit floor on frame No. 3.

The automatic pressure control consists of a cast aluminum housing, piston, reducing spring, check valve, cone-shaped screen filter, needle, needle lever, needle nut, stop, roller of stop, steel fitting for attaching the line from the sump filter, fitting with check valve for connection of the line which goes to the direct-flow filter, two tightening nuts-caps, reducing spring and stop, cover with fitting for attaching the connection line with the atmosphere and the attachment parts.

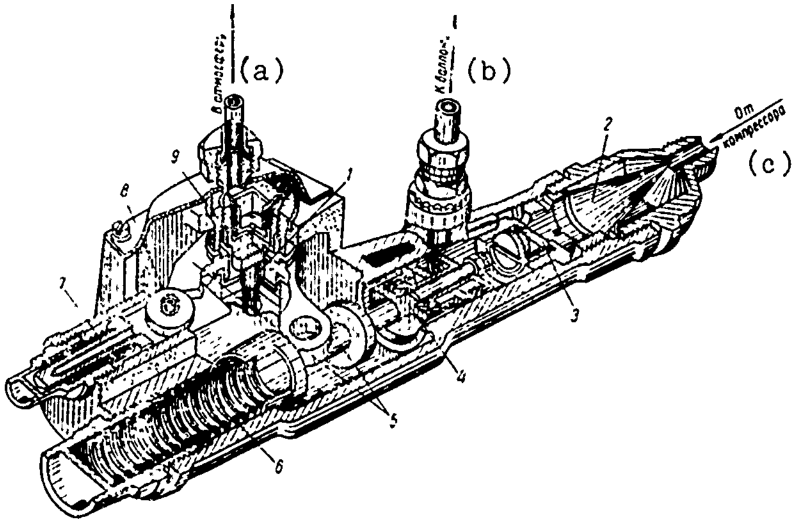

Fig. 64. AD-50 automatic pressure control: 1 – needle; 2 – filter; 3 – check valve; 4 – piston; 5 – lever of needle; 6 – reducing spring; 7 – stop; 8 – roller of stop; 9 – nut of needle.

KEY: (a) To atmosphere; (b) To bottle; (c) From compressor.

With pressure reduction in the bottle to 40 kgf/cm^2 the air, being forced by compressor (Fig. 65), passing through the screen filter of the automatic control, opens the check valve and is forced into the bottle. When the pressure in the bottle reaches 50 + 4 kgf/cm^2, the air presses the piston, which compresses the reducing spring, adjusted to 54 kgf/cm^2, and turns the needle lever. The needle, incoming with flat faces into the appropriate seat of the lever, rises and opens the hole for the air outlet through a side channel into the atmosphere. By air pressure the check valves are shut, which prevent the exit of air from the cavity of the automatic control and the bottle.

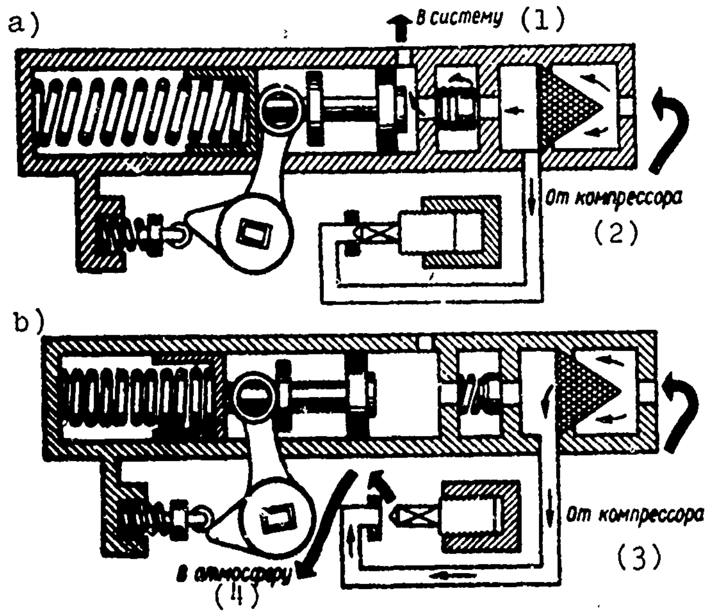

Fig. 65. Diagram of operation of AD-50 automatic pressure control: a) pressure in system is less than 50 kgf/cm^2; b) pressure in system is more than 50 kgf/cm^2.

KEY: (1) To system; (2) From compressor; (3) From compressor; (4) Into atmosphere.

During operation there is observed pressure reduction of air in the system because of wear of the rubber sealed piston or jamming of the reducing spring. In this case the automatic pressure control must be replaced by a new one.

Direct-flow filter (Fig. 66) is intended for purifying the air fed into the bottle. In the filter housing there is a series of metal screens and felt gaskets, serving for purifying the air. The air flow direction is shown in Fig. 66 by a pointer. Direct-flow filter is mounted on frame No. 3 next to the automatic pressure control.

The KN-50 filling cock (network cock) is installed on the left cockpit panel. The cock consists of the housing, into which a locking needle with spring and handwheel is installed, reducing valve, fittings and guide nut of the needle.

When turning the handwheel clockwise the cock needle is lowered along the thread in the housing and cuts off the channel in the lower fitting, which supplies air into the aircraft bottle. The reducing valve is constantly connected to the delivery line regardless of whether the cock is open or closed. The valve spring is adjusted to air pressure 50 + 5 kgf/cm^2.

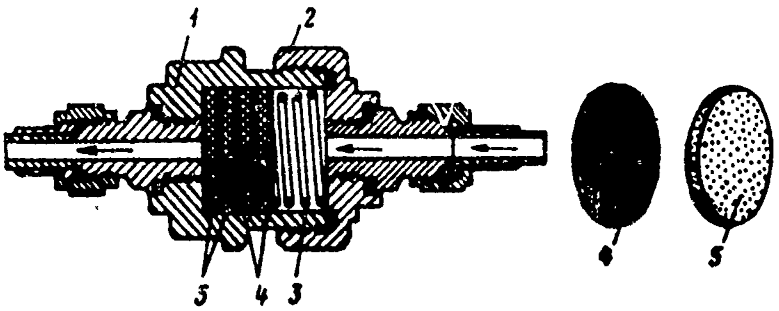

Fig. 66. Direct-flow filter: 1 – housing; 2 – cover; 3 – spring; 4 – screen; 5 – gasket.

If the air pressure in the delivery line for any reason rises, the excess air is released through openings in the housing into the atmosphere.

When the aircraft is parked the filling cock should always be closed, before takeoff – open.

The pressure gauges of the pneumatic system are arranged on the left cockpit panel next to the filling cock. The 80 kgf/cm^2 pressure gauge, connected between the filling cock and bottle, constantly shows the bottle pressure.

The 12 kgf/cm^2 two-pointer pressure gauge for brakes serves for monitoring the pressure separately in the brakes of the right and left wheel.

The compressed air bottle with capacity 8 l is spherical, welded from two hemispherical shells stamped from 30KhGSA steel 2 mm thick. To each hemisphere there is welded one fitting. The upper fitting serves for filling the bottle with compressed air as well as for air flow, lower – for drain of condensate.

The bottle is designed for operating pressure 50 kgf/cm^2 with 3.5 safety factor. After welding the bottle is normalized and painted outside with black enamel. The bottle is located under the cockpit floor on the right side on a bracket with a recess in the shape of the bottle. The bracket is attached to stringer No. 4 of the fuselage, to the bottom spar and the fuselage skin between frames Nos. 2 and 3. The bottle is fastened to the bracket by a yoke, which consists of a cup and strips welded to it. The strips are tightened by bolts. Under the cup, bracket and strips there are laid rubber gaskets.

PU-7 reducing valve (Fig. 67) serves for reduction (lowering) of the air pressure, entering from the aircraft bottle under pressure 40-54 kgf/cm^2 to pressure 6-10 kgf/cm^2, necessary for control of brakes of the wheels or skis.

The PU-7 valve of the brake control system is installed in the cockpit on the left control column at its top part and consists of the following basic parts: housing 5, cast from aluminum alloy, reducing spring 6, piston 4, "stocking" rubber membrane 3, pusher 1, nut 18, clamping ring 17, large discharge valve 7, small discharge valve 8, large inlet valve 15, small inlet valve 13, spring of large inlet valve 12, spring of large discharge valve 16, air bleed fitting 10 from PU-7 to brakes, air supply fitting 11 from bottle to PU-7 valve and other parts.

The valve has three cavities: upper 2, middle 9 and lower cavity 14. The upper cavity is connected with the atmosphere through openings in the pusher, the middle cavity is connected by an oblique channel in the housing to the line, which goes to PU-8/1 differential, and the lower cavity is connected to the line which goes to the aircraft bottle.

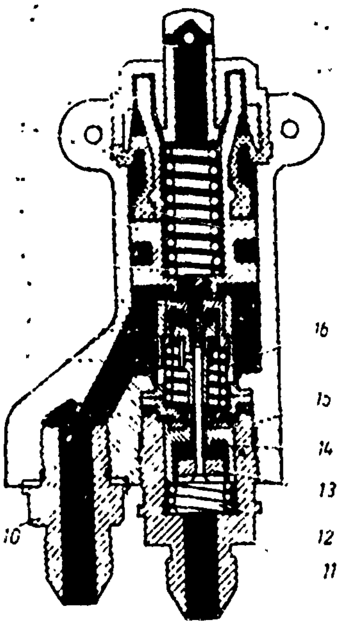

Fig. 67. PU-7 reducing valve.

Valve operation. The PU-7 valve has two positions: "Released" and "Braked."

In the "Released" position (Fig. 68a) the brake control trigger button is released, reducing spring 6 is in the expanded position, with this the large and small discharge valves are open, and the large and small inlet valves are closed. The middle cavity 9 is connected with upper cavity 2 through the open small discharge valve 8, the opening of the large discharge valve 7 and the central opening of piston 4, with this the air from the brakes can freely exit into the atmosphere through the opening in pusher 1.

With pressure on the brake button (Fig. 68b) the force is transferred through the rigid rod located inside the axle of the left steering control, and through the L-shaped lever to the pusher.

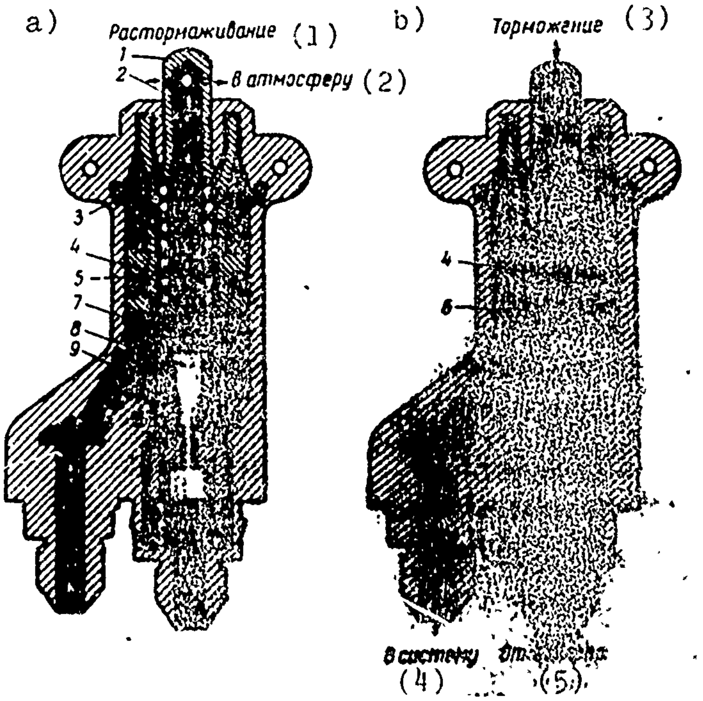

Fig. 68. Diagram of operation of PU-7 valve: a) "Released position"; b) "Braked" position.

KEY: (1) Brake release; (2) To the atmosphere; (3) Braking; (4) To system; (5) From bottle.

The pusher in turn presses the reducing spring 6, which, compressing, transfers force to piston 4, moving it downward. The piston, resting by its seat into a rubber pad of the large discharge valve, will move this valve until it contacts the small discharge valve, having separated the brake system with the atmosphere. During further motion of the pusher downward the small inlet valve is opened. Compressed air from the aircraft bottle passes through the lower and middle cavities of PU-7 valve into the brake system. With opening of the small intake valve the air pressure under the large inlet valve will sharply drop and as a result of the pressure differential above the valve and under it the large inlet valve will open a large air passage hole, which will considerably accelerate the braking process (see Fig. 68b). With change in the force of pressure on the brake button, and consequently, on the pusher and reducing spring the pressure of air being admitted into the brake system is changed accordingly.

The movement of the button is limited by an adjusting screw, installed on an L-shaped lever.

With replacement of PU-6, being installed on aircraft up to series 110-11, by valve PU-7 instead of adjusting screw 1315S51-4-22 there is placed Sh5120-1 screw with head down.

Differential PU-8/1 (Fig. 69) is intended for simultaneous and independent braking of wheels or skis of the landing gear. It is installed on Sh5210-112 bracket in front of the left pedal control and with its lever is connected with a spring rod to the rocker of the foot pedal control.

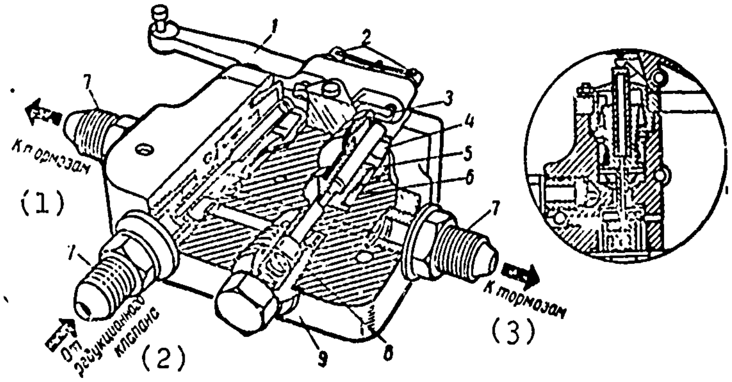

Fig. 69. PU-8/1 differential (in the circle is shown the position of the piston in the chamber with air intake from PU-7).

KEY: (1) To brakes; (2) From reducing valve; (3) To brakes.

Differential PU-8/1 consists of housing 9, lever 1, rocker 3, two pistons 5, two "stocking" membranes 6, two safety (intake) valves 8, two clamping rings 4, two adjusting screws 2 and three fittings 7. The two lateral fittings are connected to the lines which go to the wheel brakes, and one – to the line which goes to the PU-7 reducing valve.

The safety valves with the aid of springs are constantly pressed with their rubber seals (pads) to the ends of the piston rods, in which there are axial openings for air outlet from brakes into the atmosphere with separate wheel brake releasing (Fig. 70a, c).

The operation of PU-8/1 differential. With the neutral position of the foot control pedals of the rudder and with pressure on the button of PU-7 reducing valve there occurs simultaneous braking of both wheels or skis (Fig. 70b). With this the compressed air, entering from PU-7 reducing valve, moves pistons 3 forward to the stop in rocker 2 and goes across the slot between the safety valves and the differential housing to the wheel brakes, where there occurs simultaneous braking of both landing gear wheels or skis.

If we release the brake button of PU-7 valve (to remove pressure from the pusher), then air along the same channels of the differential will exit the brakes into the atmosphere through PU-7 valve (Fig. 70a).

The independent braking of wheels is accomplished in the following manner. With pressure on the button of PU-7 valve and deflection of foot pedal control the force is transferred through the spring rod to the differential lever (Fig. 70c). In this case, if we press on the right foot pedal control, the right wheel is braked and, on the contrary, with pressure on the left pedal – the left wheel is braked, and right is released.

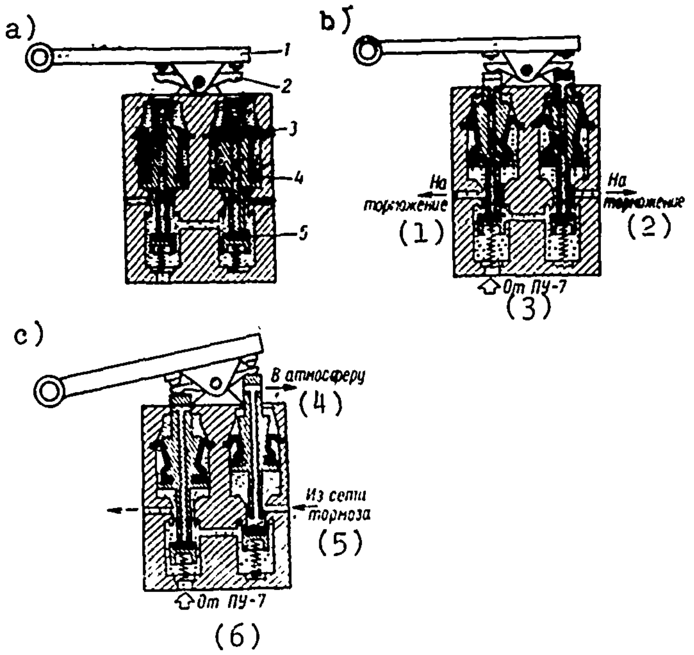

Fig. 70. Diagram of operation of PU-8/1 differential: a) both wheels are released; b) both wheels are braked; c) left wheel is released; 1 – lever; 2 – rocker; 3 – piston; 4 – "stocking" rubber membrane; 5 – safety valve.

KEY: (1) To braking; (2) To braking; (3) From PU-7; (4) Into the atmosphere; (5) From the brake lines; (6) From PU-7.

Let us observe the air travel in this case. With pressure on the right pedal the rocking arm of the pedal, turning in the pedal control column, pulls to itself the spring rod of the differential lever.

The differential lever presses the right side of rocker 2, which in turn sends the right piston of the differential forward (in the figure downward).

The left piston of the differential with the removal of load from it and under the air pressure on it will be moved in the opposite direction to the right piston, i.e., back. Until the safety valve with its rubber pad rests in the seat (annular flange) of the housing, the left wheel in this case will still be braked. As soon as the valve reaches the seat of the housing and rests in it, with further movement of pedals and pistons the front rod of the left piston will withdraw from the rubber pad of the valve and the air outlet from the brake of the left wheel into the atmosphere through the opening in the piston will be opened (see Fig. 70c). The right wheel in this case will remain braked.

With pressure on the left step of the rudder foot pedal controls there will occur the reverse action in the operation of the differential.

The maximum deflection angle of the differential lever is 30°. The deflection angle of the differential lever, at which wheel brake releasing is begun, is 14°. With the absence of pressure in the brakes between rocker 2 of the differential and the piston rods 3 there is a clearance (see Fig. 70a), necessary for the free travel of the foot pedal controls with deflection of the rudder in flight, in order that the rocker of the differential would not press the pistons and would not cause their movement and wear. For regulating the synchronization of the braking of wheels and skis of the landing gear on the differential lever there are adjusting screws.

The lines of the pneumatic system are mainly made of T6 × 4 tubes with the exception of the line from the sump filter to the automatic pressure control, which is made from T8 × 6 tubes. The lines are manufactured from AMgM.

The connection of the lines with fittings is accomplished on a conical pipe expansion without an intermediate insert and with an intermediate insert ("Parker" type). The lines are fastened to the airframe by means of blocks and clamps. The clamp on frame No. 6 is metallized.

All lines before installation are tested under air pressure 75 kgf/cm^2 for 5 min. The lines of the pneumatic system are painted black.

Flexible metal-clad hoses, which consist of a rubber hose in metal braiding 4 × 14 mm in size, serve for supplying air to the wheel brakes. The hoses are placed inside the front landing gear struts and semiaxles.

The metal-clad hoses are tested under air pressure 15 kgf/cm^2.

Part of the wiring to the PU-7 reducing valve under the cockpit floor is made from RSD medium-pressure rubber hose.

The hoses before installation are tested under air pressure 75 kgf/cm^2 for 5 min.

For charging the aircraft bottle from the airport bottle on the aircraft the charge fitting is mounted on a panel opposite the hatch on the right side of the fuselage between frames Nos. 3 and 4; to it is screwed a check valve.

Recharging fitting of the shock absorber struts and inner tubes of aircraft tires is mounted underneath on the fuselage skin between frames Nos. 3 and 4.

The fittings for recharging the shock absorber and inner tube of the aircraft tire of the tail wheel is led out to frame No. 23 opposite the hatch on the right side of the fuselage frame.

Functional Check of the Brake System

The functional check of the brake system is performed at air pressure in the overall air system 40-54 kgf/cm^2.

Before the functional check of the brake system it is necessary to check its airtightness, for which it is necessary to set the pedals in the neutral position, press the brake control button, shut the KN-50 cock and, holding the button in the indicated position for 2-3 min., check the air pressure by the two-pointer pressure gauge. There should not be a lowering of air pressure.

Release the brake control button and check the air pressure in the brake system by the two-pointer pressure gauge. The air pressure should be equal to 0. The time of wheel brake releasing is equal to 1-1.5 sec.

Then press the button and, alternately deflecting the foot pedal controls, check the normal operation of the PU-8/1 differential. With delay of the braking of one of the wheels relative to the other it is necessary to adjust the PU-8/1 differential or find the reason for the late brake release of the wheel.

The delay of braking of one of the wheels can lead to sharp turning of the aircraft, especially on its landing run.

CHAPTER IV

AIRCRAFT CONTROL

Aircraft control includes the control systems of ailerons, elevator, rudder, flaps, trim tabs of controls and ailerons and wheel and ski brakes of the landing gear.

Aircraft control is dual and consists of hand and foot controls. The control-wheel assembly of the hand control and pedals of foot control are mounted on two load-bearing beams of the cockpit floor. The beams receive all the loads appearing during the transmissions of forces to controls and ailerons.

The beams have U-shaped cross section with bottom edges bent back. The bottom part of the beams is edged partially with duralumin 0.6 mm thick. In the covering there are holes for checking the condition of cables, for the installation of rollers and mounting of the cable attachment quadrant to the left foot control and the mounting bracket of the tie rod to the right foot control. At the upper web of the beams there are openings for passage of the steering columns and pedal brackets, and also holes for access to the hinges of the tie rod, which connects the right and left foot controls; the last openings are closed with threaded plugs.

On the inner sides of beams at the mounting place of the control-wheel assembly there are riveted reinforcing brackets. The bracket on the left beam is supported by a strut with a bracket for rollers, installed underneath at the front end of the beam.

Transmission from the control column and the foot control pedals to the controls and ailerons is accomplished by means of cables and rigid rods.

The right column of the control-wheel assembly and the right foot control can be removed without disturbance of the transmission to controls and ailerons, for which it is necessary to remove the control cables of ailerons from the right control wheel and the tie rod between the brackets of the foot control under the cockpit floor.

Control of the upper and lower flaps - electric remote and is accomplished from two separate UZ-1AM electrical mechanisms. Transmission from UZ-1AM electrical mechanisms to the flaps is rigid and is accomplished by means of rods. Upper wing flap control is kinematically connected with the aileron control so that with lowering of flaps the ailerons hang and work as flaps.

Trim-tab control is also electric remote and is accomplished from UT-6D electrical mechanism.

Landing gear brake control is pneumatic with leverage from the button on the left control wheel to PU-7 reducing valve and from the foot control pedals to PU-8/1 differential.

§ 13. CONTROL-WHEEL ASSEMBLY

Elevator and aileron control includes foot control and is accomplished with the aid of the control-wheel assembly (Fig. 71).

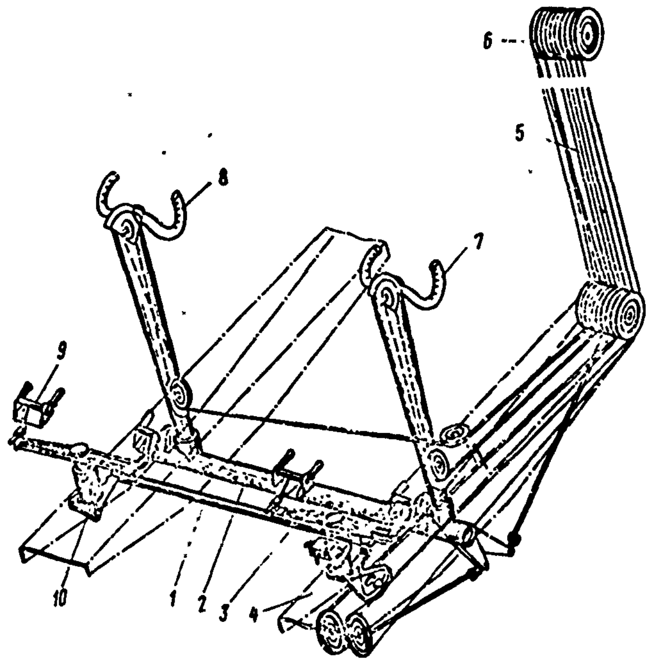

Fig. 71 Control wheel assembly: 1 - rod; 2 - cross tube; 3 - lever; 4 - load-bearing beam; 5 - cables; 6 - rollers; 7 - left control wheel; 8 - right control wheel; 9 - right pedal; 10 - bracket.

The control-wheel assembly consists of a duralumin cross tube made of D16T material, two box section control columns and two control wheels.

Duralumin cross tube of the hand control with fittings (Fig. 72) is suspended from the inner webs of the longitudinal load-bearing beams of the cockpit floor on two brackets, welded to the joints, in which there are mounted the races of two ball bearings. The joints, made from steel, are mounted on the reduced ends of the duralumin cross tube and riveted to them.

On the joints there are also welded vertical sleeves (seats) under the control columns and on the left bracket there are welded levers for attachment of the elevator control cables.

Control columns (Fig. 73) - box section, are riveted from two duralumin stamped conical-shaped sections. To the butt ends of the column are mounted and welded steel sleeves with welded on brackets for attaching the aileron control rollers.

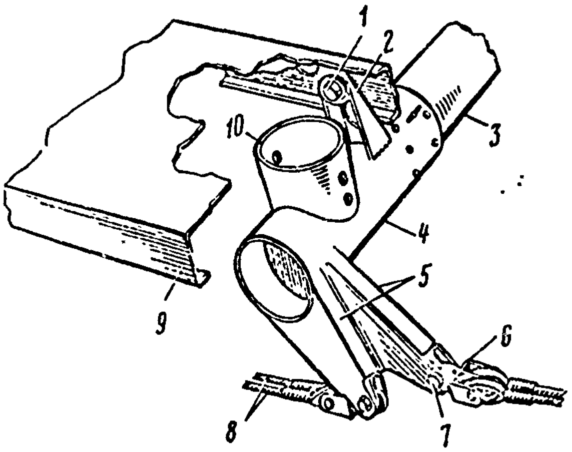

Fig. 72. Cross tube with joints and its mounting to the load-bearing beam: 1 - bolt; 2 - bracket; 3 - duralumin cross tube; 4 - steel joint; 5 - elevator control levers; 6 - link; 7 - bolt; 8 - cables; 9 - left load-bearing beam of the cockpit floor; 10 - vertical load-bearing sleeve with two openings for the attachment of control columns.

In the upper part of the column are welded the front and rear brackets, in which there are pressed the races of two ball bearings under the axle of the control wheel. On the rear bracket below the axle of the control wheel there is a three-edged lug, in which rest the heads of adjusting bolts, which limit the deflection of the control wheel at a 90° angle. On the left control column from the front with bolts there is attached a bracket with reducing valve PU-7.

Each column is inserted into the seat of the joint and fixed in it by two tapered bolts. For limitation of the deflection of control columns on the load-bearing beams of the floor there are installed stops: upper - in the cutout of the beam and lower - under the beam.

The control wheel consists of a steel axle, hollow barrel and two grips. The grips are made from Chromansil tubes welded to a hollow barrel. The barrel on the pilot's side is closed with an aminoplast cover, installed on threads. On the barrel of the left control wheel there is a slot and two eyes for attachment of the brake button. The barrel with the help of a flange by three bolts is connected to the washer welded at an incline toward the axle of the control wheel.

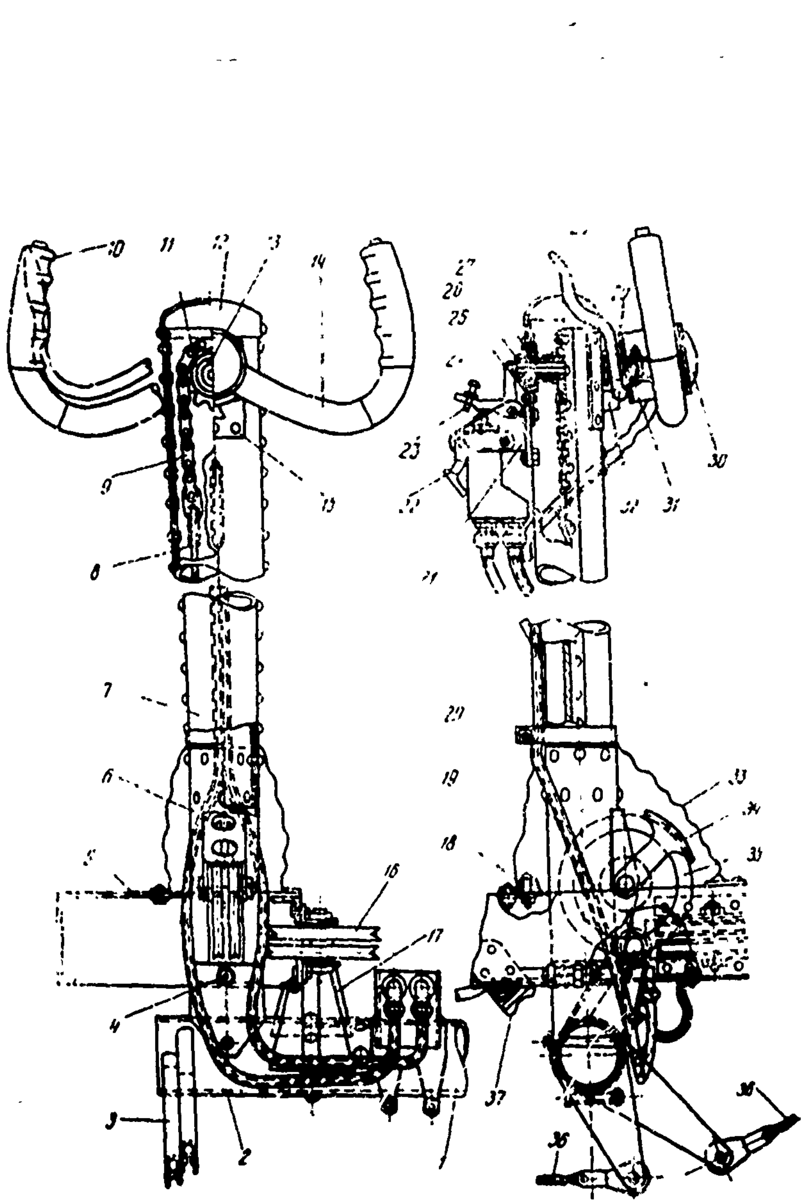

Fig. 73. Control column (left): 1 - duralumin cross tube 60 × × 57 mm; 2 - steel joint (end bracket); 3 - elevator control levers; 4 - tapered coupling bolt of the control column to the vertical sleeve; 5 - left load-bearing beam of the cockpit floor; 6 - control column bracket; 7 - control column; 8 - aileron control cable; 9 - bush-roller chain (roller chain); 10 - rubber tip of the control wheel grip; 11 - toothed gear of control wheel axle (sprocket); 12 - cap of control column; 13 - spline; 14 - control wheel; 15 - rear bracket of the control wheel axle; 16 - aileron control rollers; 17 - mounting bracket of cross tube; 18 - upper stop of control column; 19 - air lines of brake system; 20 - attachment yoke of the control column cover; 21 - bracket of PU-7 reducing valve; 22 - parking brake catch; 23 - limiting screw of movement of the clamping lever of PU-7 valve; 24 - clamping lever of PU-7 valve; 25 - front bracket of the control wheel axle; 26 - control wheel axle; 27 - rod; 28 - wheel brake control trigger button; 29 - washer of the control wheel axle; 30 - cap of the control wheel drum; 31 - control wheel drum; 32 - limit stop of control wheel; 33 - cover; 34 - safety lock; 35 - aileron control rollers; 36 - elevator control cables; 37 - bottom stop of control column.

The axis of the control wheel - is turned, hollow, is mounted on two ball bearings in the upper part of the control columns and is attached by a nut. Inside the column on the axle of the control wheel, on a spline there is placed a gear (the sprocket) with nine teeth, over which is thrown a bush-roller chain (roller chain). To the ends of the chain are connected cables, passing inside the column to the bottom rollers, mounted on the column.

On the control grips there are installed rubber tips and there are mounted buttons for actuating the command radio set and the aircraft intercom [SPU] (CPY).

Strands from the column are conducted inside the grip of the control wheels through the barrel and column. For checking the condition of the gear and roller chain at the top of the column with two screws there is installed a removable cover.

During operation of the aircraft there were observed cases of the appearance of cracks in the sprocket gear at the cutout place under the spline and cracks in the washer of the axle of the control-wheel column.

On aircraft of the 34 series there are installed an axle with increased thickness of washer and gears of increased precision of manufacture. The gears are manufactured from forgings with increased outside diameter of hub and gear.

During maintenance after each 300 h of flight it is necessary to inspect the gears with the aid of a 5 power magnifier, focusing specific attention to the cutout places under the spline, and also to inspect the attachment washers of the axle to the barrel of the control wheel with the aid of a 10 power magnifier. With the detection of cracks in the gear or washer it is necessary to replace them with reinforced, whereupon it is advantageous to replace the axle and gear in the complete set.

§ 14. FOOT CONTROL PEDALS

The foot control is dual and is designed for control of the rudder. Each pedal of the foot control (Fig. 74) consists of the bracket (column), cast from AL9 aluminum alloy, hollow vertical steel axle, double-arm yoke attached to the axle, two brackets installed on the ends of the yoke, two footrests of adjustable length, two steel footrest rods and attachment nut of the axle in the bracket.

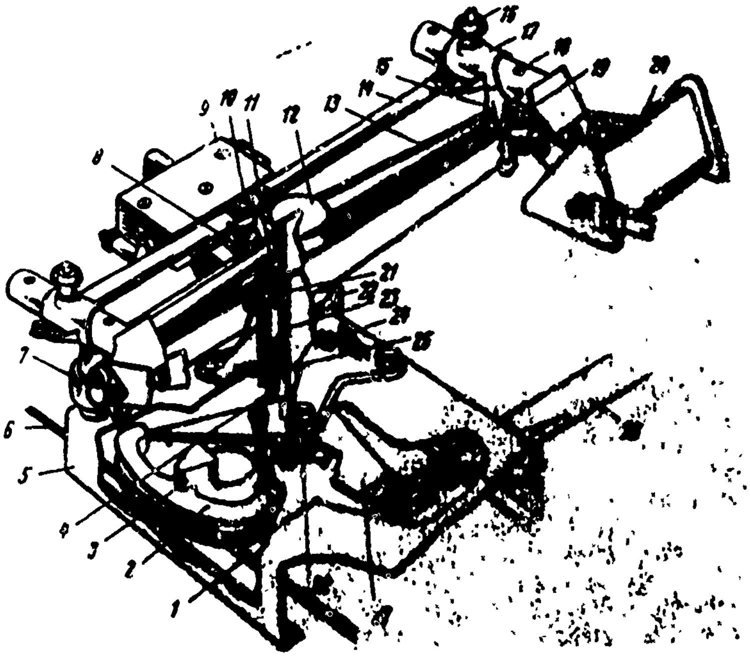

Fig. 74. The left pedal of foot control: 1 - cable; 2 - quadrant (sector); 3 - limit stop of quadrant; 4 - nut; 5 - left load-bearing beam of the cockpit floor; 6 - cable; 7 - foot stop; 8 - screw; 9 - D-1 differential (on aircraft up to the 115 series); 10 - stud; 11 - bracket cap; 12 - lever cap; 13 - pedal lever; 14 - equalizing rod of the pedal footrest (rod of parallelogram); 15 - footrest bracket; 16 - footrest rod stop; 17 - guide rod; 18 - footrest rod; 19 - roller bearing; 20 - footrest; 21 - upper roller bearing of pedal; 22 - bracket of pedal assembly; 23 - axle of pedal lever; 24 - valve lubricating screw; 25 - lower roller bearing of pedal; 26 - rod of the lever of the right pedal; 27 - quadrant lever; 28 - tapered attachment bolt of the quadrant on the lever axle.

On the lower end of the axle of the left pedal there is mounted the quadrant stamped from AK6 alloy for attaching the rudder cables. On the lower end of the axle of the right pedal there is mounted a single-arm lever for connection by means of a rigid rod with the lever which is located on the quadrant of the left pedal.

The bracket (column) in the bottom part has four eyes for attachment to the load-bearing beam of the cockpit floor by four bolts and in the upper in front there are lugs. The bracket at the top and bottom has an inner cavity, in which seats have been bored. Into each seat there are pressed the external races of radial-thrust bearings, assembled from individual ball bearings, in which the axle of the lever is mounted.

The hollow axle of the lever is turned from 30KhGSA steel. On the upper section of the axle there is a flange, with which the axle rests on the balls of the upper bearing. The axle is kept from upward motion by a nut, screwed onto the axle underneath and resting with its top face into the balls of the lower bearing. The bearings are lubricated through a ball valve screwed into the housing of the bracket of the pedals. Through the valve lubricant is supplied to the inner cavity of the bracket and from there proceeds into the bearings. Between the flange of the axle and the hub of the lever there is installed a stamped cap, which protects the upper bearing of the bracket from dirt.

The lever - I-shaped section, stamped from AK6 alloy. The axle and the lever, which is mounted on the axle by its hub, are connected by six steel rivets.

To the left side of the lever of the left pedal there is fastened the spring control rod of the PU-8/1 differential.

On the ends of the lever on the top and underneath there are bored seats, into which there are pressed two radial spherical ball bearings each, on which the footrest brackets are mounted. The upper ball bearings are covered by stamped caps. The footrests with a flute riveted to them are hinge mounted on rods and can be moved forward or back depending on the height of the pilot. The position of the footrest is adjusted, depending on the height of the pilot, by readjustment of the rod in the guide tube of the footrest bracket in three different positions. The footrests on the rods and the rods in brackets are fixed by spring stops.

On the brackets of pedals in front there are lugs for attaching the equalizing rods of the footrests.

The brackets of footrests, rods, the frame of footrests and equalizing rods are made from 30KhGSA Chromansil steel.

On the lower end of the axle of the left pedal with two tapered bolts there is fastened the quadrant with two grooves for the control cables of the rudder. The quadrant has a lever, with which it is connected by means of a rod with the reciprocal lever of the right pedal.

In levers there are installed radial spherical ball bearings. On the quadrant there are two bolts for attaching the rudder cables, a three-edged protrusion for limitation of rudder deflection and a lightening hole.

On aircraft of the 85 series the construction of the control cables of the aircraft and engine is changed, in connection with this the attachment of the rudder cables on the quadrant of the left pedal is also changed (Fig. 75b).

For installation of the new construction of rudder cables on aircraft to the 84 series it is necessary in the quadrant of the left pedal to introduce two additional openings Ø8A.

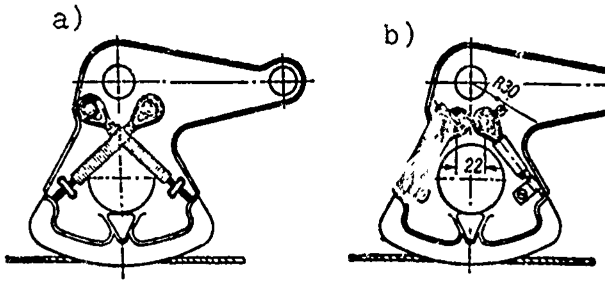

Fig. 75. Attachment of cables on the quadrant of the left pedal: a) on aircraft to the 84 series; b) on aircraft from the 85 series.

With deflection of the rudder to the left the three-edge protrusion of the quadrant rests in the rib of the bracket of the front rollers, and with rudder deflection to the right the three-edged protrusion leaves the stop with the angle plate, attached from within to the left load-bearing beam. The angle plate is arranged behind the pedals.

§ 15. CONTROL RUN OF AILERONS AND DIRECTIONAL CONTROLS

Control run of ailerons (Fig. 76) is of mixed type: from the control wheels to the double-arm actuator on frame No. 6 it is cable and from the double-arm actuator to the ailerons - rigid.

In the aileron control system there are used especially flexible 7 × 7 cables 4.5 mm in diameter, or 5.1 mm in diameter All-Union State Standards [GOST] (ГОСТ) 2172-43. For corrosion protection they have been impregnated with a mixture of 50% varnish No. 17A and 50% cottonseed oil. After 15-20 minute impregnation in a bath the cables are dried at temperature 40-45°C for 4-5 hours. The dimensions of the aileron cables (Fig. 77): length of cables from the control wheel of the first pilot to the double-arm actuator A, B - 2850 mm each and from the control wheel of the copilot to the double-arm actuator A, B - 3560 mm each.

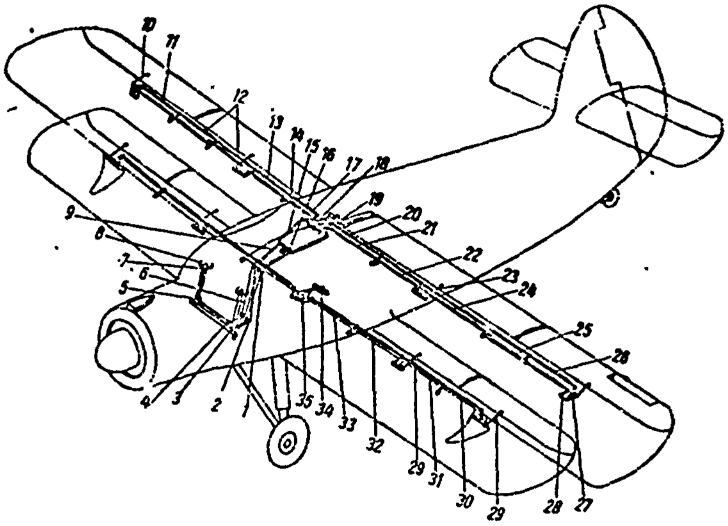

Fig. 76. Diagram of aileron flap control: 1 - upper rollers on frame No. 5; 2 - lower rollers on frame No. 5; 3 - rollers on the left control column; 4 - rollers on the right side of the left load-bearing beam; 5 - roller on the right control column; 6 - aileron control cables; 7 - sprocket under the roller chain; 8 - control wheel; 9 - aileron control cable clamps; 10 - rod to aileron; 11, 12, 13, 15, 17, 20 - aileron control rods; 16 - aileron control actuator on frame No. 6; 14, 21, 22, 24, 25, 26 - flap control rods and aileron droop; 18 - box of control gear of the upper wing flaps; 19 - upper UZ-1A electrical mechanism; 23 - rod to the upper wing flap; 28 - L-shaped actuator of aileron droop; 27 - triangular actuator of aileron deflection; 29, 30, 31, 32, 33 - lower wing flap control rods; 34 - lower UZ-1A electrical mechanism; 35 - box of control gear of the lower wing flaps.

The aileron control cables pass from the roller chain to the double-arm actuator along two single-groove textolite rollers with ball bearings, installed below on the control columns.

Rollers on the left column are installed in the longitudinal plane of the aircraft and on the right column at a 30° angle to the left of the longitudinal axis of the aircraft. From the rollers on the right control column the cables pass over the rollers installed in the horizontal position on the right side in the left load-bearing beam on brackets riveted to the web of the beam (see Fig. 73, pos. 16). Further all four control cables of the ailerons pass under the left load-bearing beam and through the lower roller joint on frame No. 5, along two double-groove rollers with ball bearings along the left wall of frame No. 5 pass upward to the upper roller joint of frame No. 5 and through two rollers - to the clamps located at the actuating arm on frame No. 6. The lower roller joint of frame No. 5 consists of six single-groove rollers for the passage of the elevator and rudder cables and two double-groove rollers for the aileron cables. The rollers are mounted on a common bolt in a bracket made of AK6 alloy. The bracket is riveted to the left load-bearing beam of the cockpit floor and to fuselage frame No. 5.

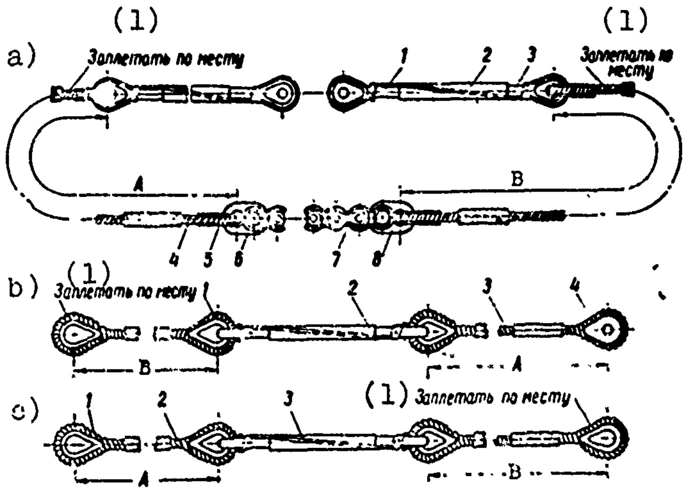

Fig. 77. Aircraft control cables: a) chain with control cable of ailerons: 1 - eye of clamp; 2 - clamp coupling; 3 - eye of clamp; 4 - cable 7 × 7 - 4.5 GOST 2172-43; 5 - thimble; 6 - roller; 7 - chain; 8 - link; b) rudder control cable: 1 - thimble; 2 - clamp; 3 - cable 7 × 7 - 3.5 GOST 2172-43; 4 - thimble; c) elevator control cable: 1 - thimble; 2 - cable 7 × × 7 - 3.5 GOST 2172-43; 3 - clamp.

KEY: (1) Plait in place.

The upper roller joint on frame No. 5 consists of a bracket and three cages with rollers. The bracket is bolted to the frames with five bolts. The frame at this point is reinforced by a ribbed cover plate.

The two extreme orienting cages, serving for attachment of the aileron rollers, are arranged closer to the axis of the fuselage. The third cage with two double-groove rollers under rudder cables is rigidly installed.

Clamps for adjustment of the aileron control cables are installed at the actuating arm of frame No. 6. The tension of the aileron control cables is 60-65 kgf.

The run from the double-arm actuator to the ailerons is accomplished by rigid rods, suspended on actuators. All the hinges of these transmissions are made on radial double-row spherical bearings. The aileron control rods pass from the double-arm actuator to the L-shaped actuators, installed on the box of the UZ-1A mechanism, and further through an opening in the fuselage skin - to the detachable parts of the upper wing (Fig. 78).

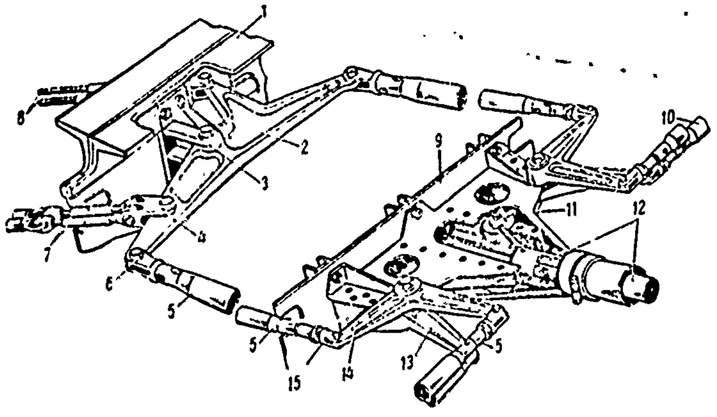

Fig. 78. Actuating arms and control rods of ailerons in the cargo compartment of the fuselage: 1 - frame No. 6; 2 - double-arm actuator; 3 - mounting bracket of actuator; 4 - link; 5 - aileron control rod; 6 - tip of rod; 7 - clamps; 8 - cables; 9 - frame No. 8; 10 - flap control rods; 11 - box of UZ-1A mechanism; 12 - rod of UZ-1A electrical mechanism; 13 - L-shaped actuating arm of flap control; 14 - L-shaped actuating arm of aileron control; 15 - tip.

In the detachable parts of the upper wing on brackets, cast from AL9 alloy, located on the rear spars between the trailing edges of ribs Nos. 1-2, 6-6, 11-12, 14-15, 17-18, there are mounted the travelling or transmission actuators, stamped from AK6 alloy.

The aileron control actuator is mounted on an L-shaped actuating arm of the aileron droop mechanism (Fig. 79).

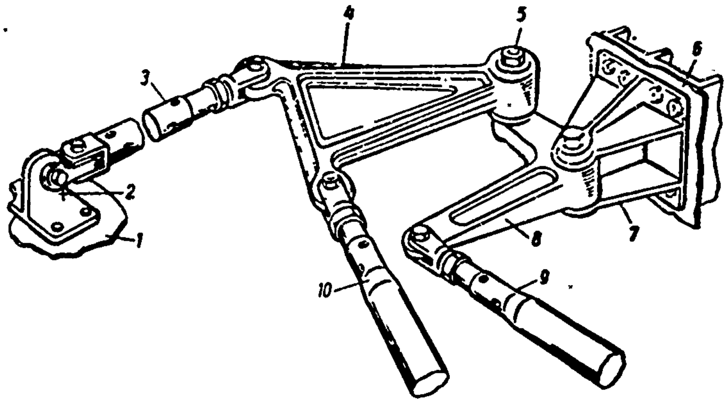

Fig. 79. Aileron droop mechanism: 1 - aileron; 2 - single-arm aileron lever; 3 - steel aileron rod; 4 - aileron deflection actuator; 5 - attachment pin of the aileron deflection actuator; 6 - spar web; 7 - bracket; 8 - L-shaped aileron droop actuator with flap deflection; 9 - rod, which goes to the flap control; 10 - aileron control rod.

The rod to the aileron control lever is made from a steel tube, the remaining rods - from duralumin. The tips of the rods are steel. The ends of the duralumin rods are swaged for weight reduction of the tips. The rods are assembled with the tips on tubular rivets.

Aileron droop at a 16° angle is accomplished by turning of the L-shaped droop actuators, connected by rods with the three-arm flap deflection actuators.

The differentiality of aileron deflection upward at a 30° angle and down at a 14° angle with neutral position of flaps is accomplished by the three-arm aileron control actuator.

During operation there occurred cases of bending of the attachment pins of the three-arm aileron control actuator to the L-shaped aileron droop actuator. The pin earlier was made from steel 45. On aircraft from the 50 series the plant manufactures pins from 30KhGSA steel.

The elevator control run, just as for ailerons, is mixed, but is predominantly cable. Cables in the run are 7 × 7 with diameter 3.5 mm or 7 × 19 with diameter also 3.5 mm GOST 2172-43. The cables - doubled and pass from the levers of the control-wheel assembly to the three-arm actuator installed on fuselage frame No. 25. From the three-arm actuator to the elevator lever passes a rod, made from steel tube. The dimensions of cables: length of cables from the rear bracket of the control-wheel assembly to clamp A - 6920 mm and from the clamp to the three-arm actuator B - 3150 mm; the length of the cables from the front bracket to clamp A - 8050 mm and from the clamp to three-arm actuator B - 3200 mm (Fig. 80).

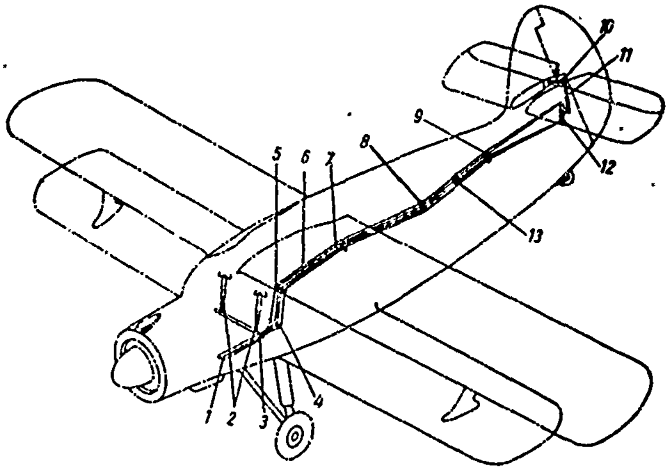

Fig. 80. Diagram of elevator control: 1 - rollers at frame No. 1; 2 - control column; 3 - hand control levers; 4 - lower rollers on frame No. 5; 5 - upper rollers on frame No. 5; 6 - cables; 7 - rollers on frame No. 8; 8 - rollers on frame No. 15; 9 - rollers on frame No. 21; 10 - elevator lever; 11 - rod; 12 - actuator on frame No. 25; 13 - clamps.

The elevator control cables pass from the levers of the control-wheel assembly through two single-groove rollers with a ball bearing, installed at frame No. 1, four single-groove rollers, installed on the bottom joint of frame No. 5, two double-groove rollers, installed on the top joint of frame No. 5, four single-groove rollers with a ball bearing, installed on the bracket of frame No. 8, through self-aligning rollers with ball bearing and further through rollers along frame No. 21 to the levers of the three-arm actuator (Fig. 81) installed on frame No. 25.

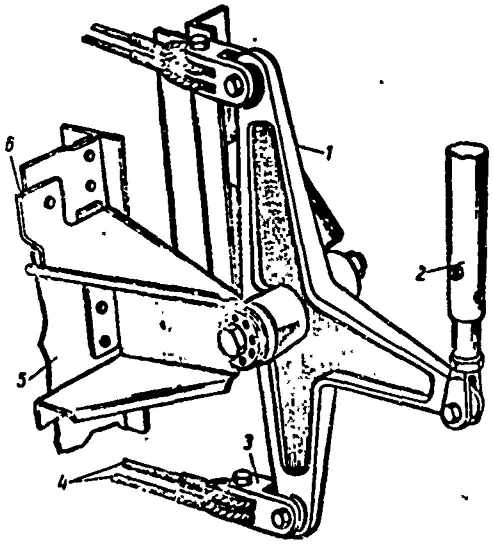

Fig. 81. Three-arm actuator of elevator deflection on frame No. 25: 1 - actuator; 2 - rod; 3 - link; 4 - cables; 5 - frame No. 25; 6 - bracket.

The roller joint at fuselage frame No. 1 consists of three rollers, from which two rollers are intended for the passage of cables, the elevator from the front lever and one roller for the rudder cable. The rollers are installed on a bracket, cast from AL9 alloy, which is riveted to the left load-bearing beam of the cockpit floor underneath and to fuselage frame No. 1.

The joint on frame No. 8 consists of six rollers, mounted together with a safety device on one common bolt on a bracket made of AL9 alloy. The bracket is bolted to the frame with four bolts.

The rollers at frame No. 15 are mounted in the aligning cages: two cages on two rollers - under the elevator cables and two cages on one roller - under the rudder cables. All the cages are assembled in one common bracket, stamped from sheet duralumin and riveted to stringers and to the outer fuselage skin.

On frame No. 21 there are installed two cages on two rollers in each cage under the elevator cables. The cages are hung on bolts in the bracket, riveted to the frame and to the lower rib of the fin section of the fuselage. The bracket is made of sheet duralumin and is hardened.

The cages of rollers are installed on frames Nos. 15 and 21 and are fixed in brackets by bolts at certain angles, so that the cables would pass along the grooves of the rollers without misalignment.

The clamps of the elevator cables are installed in the tail section of the fuselage. The tension of the elevator cables is 50-55 kgf.

Rudder control run (Fig. 82) is cable, single. The cables are 7 × 7 GOST 2172-43 or 7 × 19 with diameter 3.5 mm and pass from the quadrant of the pedals through the roller at frame No. 1, then through the four rollers installed on the lower and upper joints of frame No. 5, two rollers, installed on frame No. 8, and through four rollers, installed at frame No. 15 and on frame No. 25, and are fastened to the levers of the rudder.

On frame No. 25 the rollers are installed on two separate brackets, cast from AL9 aluminum alloy. Each bracket is bolted to the wall of the frame with three bolts.

The dimensions of cables (see Fig. 77): left cable - from the quadrant of pedals to clamp A - 8160 mm and from the clamp to the left lever of the rudder B - 2960 mm, right cable - from the quadrant to clamp A - 8360 and from the clamp to the right lever of the rudder B - 3000 mm.

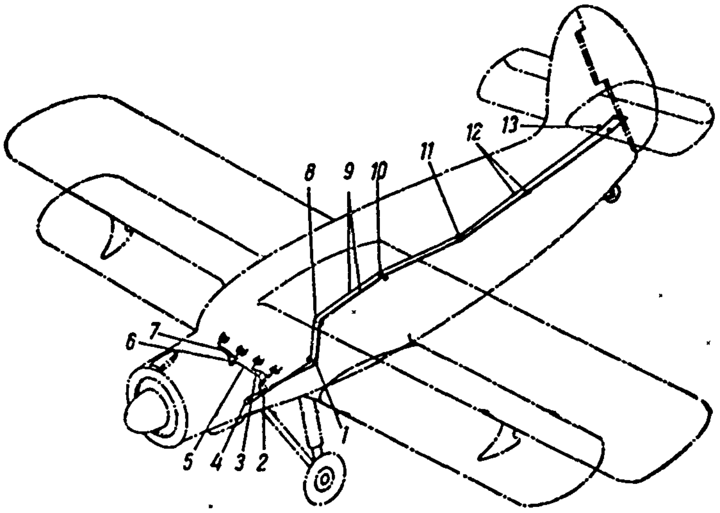

Fig. 82. Diagram of the rudder control run: 1 - lower rollers on frame No. 5; 2 - left pedal quadrant; 3 - left pedal; 4 - roller at frame No. 1; 5 - connecting rod of right and left pedals; 6 - lever of right pedal; 7 - right pedal; 8 - upper rollers on frame No. 5; 9 - cables; 10 - rollers on frame No. 8; 11 - rollers on frame No. 15; 12 - clamps; 13 - rollers on frame No. 25.

The clamps of the rudder control cables are placed in the tail section. The tension of the rudder cables is 40-45 kgf. The tension of the aircraft control cables is measured on the vertical part at frame No. 5 with the aid of IN-11 tensometer, the action of which is based on deformation of the flat spring, which appears with sag of the stretched cable.

§ 16. FLAP CONTROL

Control of the upper and lower flaps (see Fig. 76) is remote and is accomplished from the cockpit with the aid of the UZ-1AM electrical mechanisms located between frames Nos. 8 and 9, one in the upper fuselage, the other under the cargo compartment floor.

The control mechanism of upper flaps (Fig. 83) consists of a box with linkwork enclosed in it, direct-current reversing electric motor, worm reducer and ball-and-screw unit.

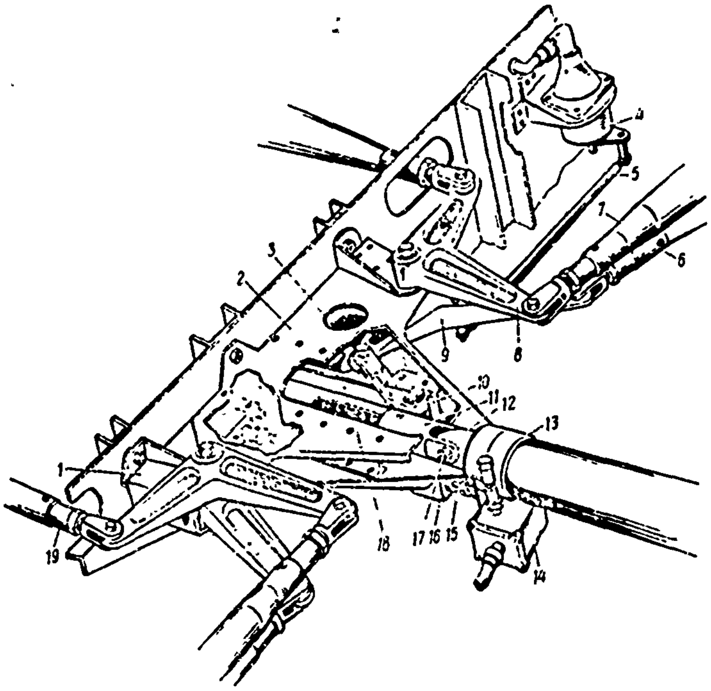

Fig. 83. The UZ-1A electrical mechanism of the upper wing flap control: 1 - bracket; 2 - box of the mechanism; 3 - guide; 4 - sensor of the flap deflection indicator; 5 - rod of sensor; 6 - flap control rod; 7 - aileron control rod; 8 - aileron control actuator; 9 - flap control actuator; 10 - ball bearing of slider; 11 - slider; 12 - rod of electrical mechanism; 13 - yoke; 14 - rear end switch; 15 - adjustable pin of end switch; 16 - adjustable stop; 17 - bolt; 18 - guide section; 19 - aileron control rod.

The box of the mechanism is made from two stamped duralumin halves, connected together on rivets by steel sections and brackets. Along the sections there moves a slider, equipped with two pairs of ball bearings for reduction of the friction forces. The motion of the slider through the guides is transferred by the actuators, from which the rods go to the flaps.

Brackets, sliders and guides are manufactured from Chromansil steel 30KhGSA. The sections are made from forgings of steel 45 and are normalized. For reduction of wear of the sections the surface, along which the ball bearings roll, is chrome-plated.

The UZ-1AM electrical mechanism consists of MUK-421 direct-current reversing electric motor, worm reducer and ball-and-screw unit. The screw pair is enclosed in a cylindrical casing, bolted to the electric motor housing. The nut of the screw pair is terminated by a working rod, which during operation of the electric motor moves reciprocally in some direction, depending on the direction of reversing. The eye of the rod is bolted to the fork of the slider.

For mounting the electrical mechanism to the housing the rod is provided with a rim, which enters the neck of the housing and is tightened in it by a yoke.

The upper electrical mechanism is fastened to the fuselage frame with two yokes. On the box of the upper UZ-1AM electrical mechanism on one bolt with L-shaped flap actuators there are mounted the L-shaped aileron control actuating arms.

The UZ-1AM electrical mechanism for lower flap control (Fig. 84) in its construction is identical to the electrical mechanism for upper wing flap control, with the exception of the aileron control actuators.

The supply circuits of UZ-1AM are equipped with separate circuit breakers, the buttons of which are located on the central electrical panel of the instrument board. The actuation of the UZ-1AM electrical mechanism is produced by buttons: the lowering of flaps - by a knob on the throttle control, retraction - by a knob on the central panel.

The electrical mechanisms operate until the knobs are actuated and therefore the flaps can be stopped in any position within limits of the operating range. In the extreme positions the flaps are stopped automatically with the aid of two end switches.

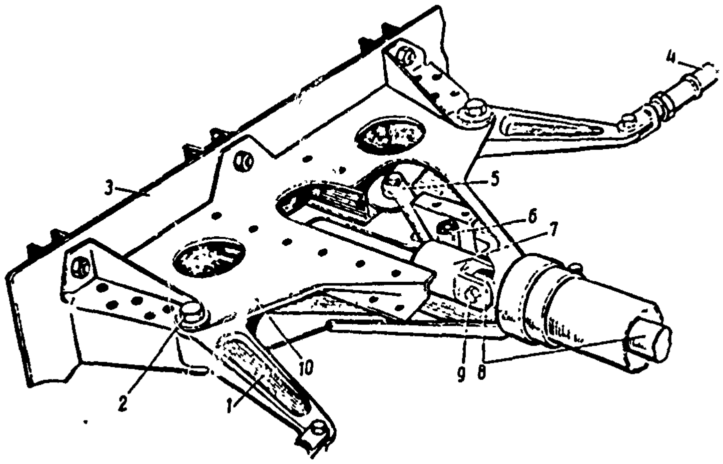

Fig. 84. The UZ-1A electrical mechanism for lower wing flap control: 1 - actuating arm; 2 - bolt; 3 - bottom part of frame No. 8; 4 - rod; 5 - guide; 6 - ball bearing of slider; 7 - slider; 8 - rod of electrical mechanism; 9 - bolt; 10 - box of the mechanism.

The position of the flaps is recorded by an electrical indicator located on the central panel. The indicator sensor is located on frame No. 8 and is connected to the L-shaped flap control actuator. The indicator is actuated by the circuit breaker on the electrical panel of the central panel (the second to the right).

The flap control run is accomplished by rigid rods through transmission actuators mounted on the same brackets where the aileron actuators are mounted.

The flap and aileron control actuators are shown in Fig. 85.

The rods, which go from the actuator to the flap-control levers, are made from steel tubes.

The flap control actuator is connected by rigid rods to the aileron droop mechanism, which is located on the rear spar of the upper wing between the trailing edges of ribs Nos. 17 and 18.

The aileron droop mechanism of the upper left wing is shown in Fig. 79. The L-shaped aileron droop actuator is mounted on the bracket installed on the rear wing spar; one arm of it is connected by a rod to the flap control, and on the other arm with the aid of a pin there is hung the three-arm aileron control actuator.

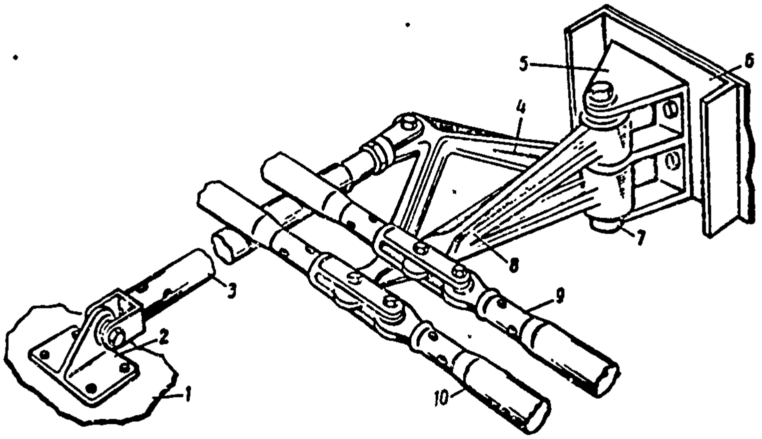

Fig. 85. The flap and aileron control actuators: 1 - flap; 2 - bracket of flap; 3 - rod; 4 - flap control actuator; 5 - bracket; 6 - spar; 7 - bolt; 8 - the transmission (travelling) aileron control actuator; 9 - aileron rod; 10 - flap rod.

With lowering of flaps the L-shaped actuators shift the three-arm aileron actuators back, which causes movement of the actuators and aileron droop.

§ 17. TRIM-TAB CONTROL

Control of aileron trim tabs, elevator and rudder is remote and is accomplished from the cockpit with the aid of UT-6D reversing electrical mechanisms.

The electrical mechanisms are mounted in the nose section on spars of the left aileron and the left half of the elevator and from behind - on the rudder spar. For access to mechanisms at the places of their installation there are hatches.

The motion screws of the mechanisms are connected with the brackets of the trim tab by rigid adjusting rods, passing inside the aileron and directional controls. The forked bolts of the control rods of the elevator and rudder trim tabs on aircraft from the 62 series are reinforced. In the brackets of the trim tabs for connection with the control rod there is inserted a ball bearing.

The trim tabs are controlled by pressure switches installed on the central panel of the cockpit; the mechanisms operate when the switches are pressed. The limiting trim change is fixed by end switches, available in the mechanisms themselves.

The UT-6D feed circuits are equipped with separate circuit breakers located on the central electrical panel next to the circuit breaker of UZ-1AM mechanism control.

The neutral position of the trim tab is signaled by blue warning lamps, located on the central panel of the cockpit between the trim-tab control pressure switches.

§ 18. BRAKE CONTROL

Control of landing gear wheel and ski brakes is accomplished by a trigger, located on the left control wheel, and by the left foot control pedals.

Trigger 28 (see Fig. 73) by means of a rod, passing through the hollow axle of the control wheel, is connected with the L-shaped pressure lever of the PU-7 reducing valve, which is installed in front of the left control column. With pressure on the trigger the lever presses the pusher of the PU-7 valve, the pusher through a reducing spring shuts the discharge valves and opens the air inlet valves, reducing it to the pressure necessary for braking the wheels or skis.

The degree of reduction of air depends upon the degree of pressure on the trigger and the motion of the lever of the reducing valve, which has a limiting screw.

The maximum pressure, for which the reducing spring of PU-7 is designed - 10 kgf/cm^2.

For wheel brakes the pressure is adjusted 6-8 kgf/cm^2, for skis - 8-10 kgf/cm^2.

When testing engine operation on the ground the lever in the pressed position can be fixed by the parking lock, mounted on the bracket of PU-7.

From the PU-7 valve compressed air enters the PU-8/1 differential and with the neutral position of the pedal lever - the brakes, which causes simultaneous braking of both aircraft landing gear wheels.

The independent braking of wheels is accomplished by deflection of the rudder control pedals (see Fig. 70c).

§ 19. ADJUSTMENT OF AIRCRAFT CONTROL

Before adjustment of the aircraft control it is necessary to set the control columns, control wheels and the foot control pedals in the neutral position.

For this there is a cabin lock, which can be used on aircraft from No. 136-01. On earlier aircraft use of the cabin lock is possible under the condition of appropriate modification of the left control column and left pedals.

Adjustment of Elevator Control

The neutral and extreme position of the control columns, and also the elevator deflection angles and the corresponding measurements (deflections) along the trailing edge of the elevator of the aircraft are given in Table 11.

Table 11.

Elevator position	Position of control columns from vertical	Elevator deflection	
		to angle	on trailing edge
Neutral	2° back	0°	-
Upper:			
to No. 133-20	23° back	35° ± 1°	344 ± 10
from No. 134-01 to No. 159-20	23° back	35° ± 1°	344 ± 10
from No. 160-01	23° back	42° + 3°	409 + 30
Lower:			
to No. 133-20	10° forward	18° + 1°	178 + 10
from No. 134-01 to No. 159-20	13° forward	22°30' ± ± 1°	224 ± 10
from No. 160-01	11°30' forward	22°30' ± ± 1°	224 ± 10

Adjustment is produced in the following order:

1) with loose cables fasten the columns and the control in neutral position;

2) adjust rod 11 (see Fig. 80) so that the upper and lower hinges of actuator 12 are equidistant from frame No. 25;

3) adjust the cables, having tightened them with force 50-55 kgf;

4) remove the stops and, deflecting the control columns to stops to both sides, check the deflection angles of the control (see Table 11).

From aircraft No. 132-01 the lower stops, which limit the deflections of control columns back, are changed and can be adjusted (see Fig. 73, pos. 37).

If the adjustment of the lower stops is disturbed, it is necessary to again adjust them to get the required deflection angle of the elevator upward.

Adjustment of Rudder Control

The deflection of foot pedals from the neutral position to both sides to the stop is equal to 30° ± 1°.

The order of adjustment is the following:

1) with slackened cables fix the left pedal and the rudder in the neutral position and adjust the cables, having tightened them with force 40-45 kgf;

2) by adjusting the rod between the left and right pedals, set the right pedal in the neutral position;

3) remove the latches and, by deflecting the left pedal to both sides to the stops, check the rudder deflection angles.

Rudder deflection to both sides should be $28^{\circ}{}^{-1}_{-2}$ or 393^{+13}_{-28} mm along the trailing edge of the rudder with respect to rib No. 6.

Adjustment of Aileron and Flap Control

Adjustment of control in the linen-covered wings is difficult, therefore the plant adjustment should not be disturbed. During replacement of the adjustable rods it is necessary to accurately measure their lengths and to adjust the new rods according to them.

If necessary the aileron and flap control should be readjusted in a certain sequence, as stated below.

Adjustment of aileron and flap control in the upper wing is performed simultaneously, since both controls have kinematic connection through the droop mechanisms.

The order of adjustment is the following:

1) remove rods 14, 17, 20 and 21 (see Fig. 76) and fix the aileron and flap in the neutral position;

2) adjust in sequence the lengths of rods so that each rod brings the appropriate actuating arm to the position shown in Fig. 86a:

by rod 1 set actuating arm 2;

by rod 3 set actuating arm 4;

by rod 5 set actuating arm 6

by rod 7 set actuating arm 8.

The indicated sequence makes it possible to adjust each rod one at a time.

Adjustment of flap control in the lower wing. It is recommended to adjust the control in the wings and in the fuselage separately, and to connect rods 33 (see Fig. 76) last, having adjusted their length in place.

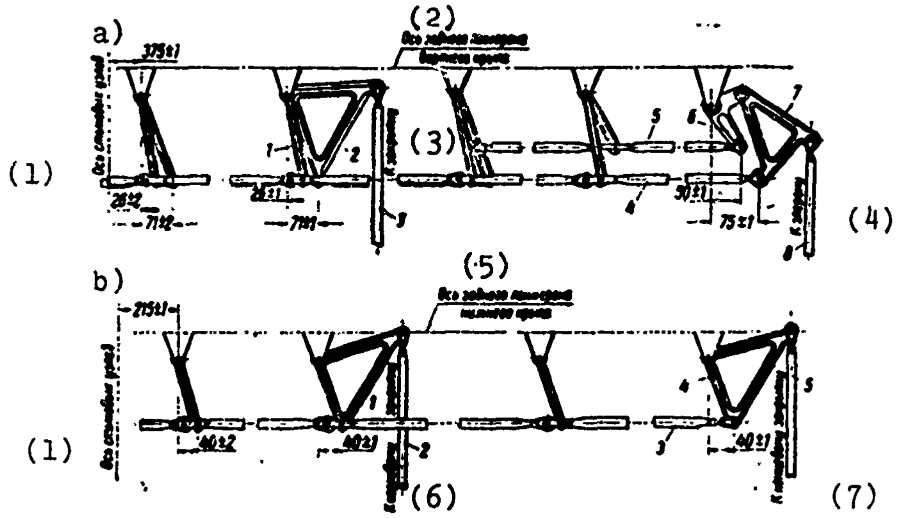

Fig. 86. Diagram of adjustment of aileron and flap control in the wings: a) right detachable part of upper wing: 1 - transmission (travelling) aileron control actuator; 2 - flap deflection actuator; 3 - rod to flap; 4 - aileron rod; 5 - rod to aileron droop actuator; 6 - L-shaped aileron droop actuator; 7 - aileron deflection actuator; 8 - rod to aileron; b) right detachable part of lower wing: 1 - root flap deflection actuator; 2 - rod to root flap; 3 - rod; 4 - tip flap deflection actuator; 5 - rod to tip flap.

KEY: (1) Axis of attachment joints; (2) Axis of the rear spar of upper wing; (3) To flap; (4) To aileron; (5) Axis of the rear spar of lower wing; (6) To root flap; (7) To tip flap.

Adjustment in the aircraft wings must be performed in the following order:

1) remove rods 33 (see Fig. 76) and fix the root flap in the neutral position;

2) adjust in sequence the lengths of the rods so that each rod brings its corresponding actuating arm to the position shown in Fig. 85b:

by rod 1 set actuating arm 2;

by rod 3 set actuating arm 4;

3) without removing the latch from the root flap, adjust

rod 5 so that the tip flap takes the neutral position.

Adjustment of aileron control in the fuselage must be performed in the following order:

1) with loose cables fix the control wheel of the left column in the neutral position;

2) adjust the aileron control cables, going from the left control wheel, so that the end hinges of the actuating arm 16 (see Fig. 76) would be equidistant from frame No. 6. Cables should be tightened with force 60-65 kgf;

3) adjust the aileron control cables, going from the right control wheel, so that the control wheel takes the neutral position. Cables should be tightened with force 60-65 kgf;

4) by adjusting rods 15, set the upper actuating arm on the upper box of the flap control mechanism so that the arms of both actuating arms are parallel to the axis of the aircraft;

5) without removing the locks from the ailerons, flaps and control wheel, adjust the length of rod 17 and 20 and connect them to the upper actuating arms of the upper box of UZ-1AM mechanism and to the actuating arms in the upper wing;

6) remove the locks from the ailerons and control wheel (do not remove the lock from flaps) and turn the left control wheel so that the left aileron is deflected upward $30^{\circ}{}^{+1^{\circ}}_{-1.5^{\circ}}$ or 263^{+8}_{-13} mm along the trailing edge of the aileron. With this the right aileron should be lowered $14^{\circ}{}^{+1^{\circ}}_{-1.5^{\circ}}$ or 124^{+8}_{-13} mm during measurement along the trailing edge. Without changing the position of the control wheel, adjust the left stops of both control wheels;

7) having turned the control wheels to the right, adjust their right stops in the same way.

Adjustment of the boxes of the flap control mechanisms. The mechanisms of the upper and lower boxes should be adjusted identically and in the following order:

1) remove rods 14, 21 and 33 (see Fig. 76). Adjust the pin of the rear end switch so that the flap control mechanism is stopped by the end switch in the rear position. The rear position is checked using the distance from the axle of the ball bearings of the rod of the box to frame No. 8. This distance is equal to 170 mm and corresponds to the neutral position of flaps;

2) fix the flaps by locks in the neutral position, adjust rods 14, 21 and 33 in place and connect them to the actuating arms in the wings;

3) remove the locks from flaps;

4) adjust the pin of the front end switch so that the flap control mechanism is stopped with flap deflection to $40^{\circ}{}^{+1^{\circ}}_{-1.5^{\circ}}$, which corresponds to measurement along the trailing edge of the upper flaps 320^{+8}_{-13} mm, lower 268^{+7}_{-11} mm.

Adjustment of **Brake Control**

We adjust the brake control with air pressure in the bottle 50 kgf/cm^2 and open filling cock.

First we adjust the PU-7 valve by the limit screw so that with full pressure on the control trigger and with the neutral position of pedals the pressure in brakes would be 6-8 kgf/cm^2

for the wheel brakes and 8-10 kgf/cm^2 for the ski brakes depending on the effectiveness of braking.

The PU-8/1 differential is adjusted with the aid of screws. The screws should contact the lever of PU-8/1 differential.

Synchronizations of pedal deflection are attained with air pressure in the brake line 4 kgf/cm^2.

By alternately deflecting the lever of the pedals, we note the beginning of wheel brake releasing (the exit of compressed air into the atmosphere through the differential) and the deflection angle of the lever of the foot control pedals.

With mismatch of pedal deflection the synchronization of the brake releasing of the landing gear wheels is adjusted by the screw on the lever of PU-8/1 differential.

CHAPTER V

POWER PLANT

The power plant includes:

1) ASh-62IR engine;
2) V-509-D9A, AV-7N-161 and AV-2 propellers;
3) engine mount;
4) propeller spinner and engine cowling (outer and inner cowling);
5) air intake system of the carburetor;
6) exhaust system;
7) engine component cooling system;
8) engine fuel system and priming system before starting;
9) oil system and oil-dilution system with gasoline;
10) engine starting system;
11) engine, cowl flap and oil-cooler flap control;
12) fire-fighting equipment.

§ 20. ASh-62IR ENGINE

On the aircraft there is installed the internal combustion ASh-62IR aircraft engine - four-stroke, gasoline, radial, nine-cylinder, air-cooled. The engine has been manufactured since 1937 and is a modification of the M-62 and M-63 engines. It has a single-speed gear-driven centrifugal supercharger and planetary type coaxial reduction gear.

The supercharger ensures obtaining take-off power 1000 hp on the ground and the maintaining of the necessary engine cruising powers up to considerable altitudes at comparatively low fuel consumption.

The reduction gear of the engine allows using a propeller of large diameter, which gives higher efficiency, thrust and, consequently, flight speed with the same engine cruising power, which reduces the fuel consumption per kilometer. There is operated an engine with variable-pitch props [VISh] (ВИШ), having hydraulic control. The crankshaft revolutions set by the pilot are automatically maintained by the constant-speed governor [RPO] (РПО), which is installed on the engine.

The ASh-62R engine - carburetor. The carburetor AKM-62IR has altitude mixture control, which automatically regulates the quality of fuel mixture with change in the flight altitude. Manual control of the altitude mixture control allows leaning the mixture in flight to $\alpha = 1.05$-1.1 at engine cruising power.

The indicated leaning-out of the mixture in practice does not impair the engine operation and considerably lowers the fuel consumption. For supplying the carburetor with fuel the engine is equipped with BNK-12BK rotary fuel pump. The large pump capacity provides considerable height power factor of the aircraft fuel system and reliable engine operation at any conditions.

Pressure in the engine oil line is created by gear-type oil pump MSh-8. The output of the pressure stage of the pump is fully sufficient for providing abundant lubrication of a large part of the friction surfaces of engine parts and operation of the propeller gear. The output of the scavenging stage of the pump ensures reliable engine operation at all conditions and flight altitudes of the aircraft.

Oil enroute to the engine is filtered by Kuno-type laminar filter MFM-25.

The ignition of the working mixture in cylinders is accomplished by an electric spark. The high-voltage current sources are two BSM-9BS magnetos installed on the engine. In each engine cylinder there are two SD-48BSM electric spark plugs.

The engine is started with the aid of the electric inertia starter RIM-24IR, having electrical and manual drives. On the engine there is installed an aircraft air compressor AK-50M, which provides the compressed air reserve aboard the aircraft, necessary for braking the wheels.

The basic structural units of the ASh-62IR engine are: cylinder-piston group, link gearing, crankshaft, valve actuating mechanism, crankcase, reduction gear, supercharger and unit drives.

At the given time in operation the ASh-62IR engines of 13 and 14 series are more perfected in structural and technological respect than those having preceded them.

The basic structural changes in engines of 13 and 14 series. In ASh-62IR engines of the 13 series the following structural changes are introduced:

1. The reduction gear is installed with reinforced ball thrust bearing.

2. Cylinder with elastic seat of exhaust valve.

3. Piston with two upper trapezoidal sealing rings.

4. Cam plate with reinforced rim and cam plate disk.

5. The double mixture distribution gear has a changed locking device of the attachment screws of the cover.

The rear cover has a washer under the packing spring of the generator drive.

6. The cylinder baffle of the oil sump is reinforced.

The structural distinctions of engines of the 14th series from 13-1. The 14th series of ASh-62IR engines has been manufactured since 1957 and has the following structural changes:

1. In the cylinder the exhaust valve seat is made hanging and for distinction of the cylinder of the 14th series from the cylinders of the other series the last rib on the sleeve is undercut.

2. The piston on engines of the 14th series is made from refractory AK4 alloy and has a smooth inner surface, so that there would not be carbon formation. The second ring groove is made with trapezoidal shape under a wedge-shaped ring for the best seal.

3. In the crank and connecting-rod assembly on engines of the 14th series there is provided:

a) in suction pipes of the 3, 5 and 6 cylinders drain tubes for preventing hydraulic shock;

b) the seat under the sleeve of the main connecting rod is chrome-plated, and the sleeve itself is copper-plated, seats under the wrist pins are chrome-plated;

c) separator tubes are increased 4 mm, and the tube of the oil jet 6 mm.

4. In the reduction gear, for the purpose of eliminating the appearance of cracks, the splines of the propeller shaft (in transfer) have smoother roundings. The planetary pinion lock is reinforced.

5. In the mixture distribution system the exhaust and intake rocker arms are installed on needle bearings. The cam plate is made together with the disk from steel. The exhaust valve stem is nitrided.

6. In the crankcase for protection from corrosion all its parts are cadmium-plated. The attachment of the cylinder to the crankcase is changed - on 14 studs instead of 16 studs. In the rear cover an opening with a flange for attaching the RPD (rotary piston engine) is plugged, and next to it are made threaded openings under the connection for measurement of the oil pressure in the engine and the connection for intake of oil to the R-9SM2.

7. Carburetor AKM-62IR is installed with economical control. On the carburetor cover there is installed a rod (baffle), which directs the air for ventilation of the housing of the altitude mixture control. For the best purification of fuel, entering the jets, there is introduced a secondary filter. The fuel pressure after the secondary filter should be 0.30-0.35 atm.

8. In the MSh-8 oil pump for elimination of the reasons for oil pressure loss, as a result of jamming of the reducing valve, the construction of the valve has been improved.

9. On the BNK-12BK fuel pump at the reducing valve cover the opening for connection with the atmosphere is plugged and the seal and the connection of the shank with the rotor are improved.

10. There are installed units: R-9SM2 rpm governor instead of R-7E and GSN-3000 generator instead of GSK-1500.

The basic technical data of the engine

Engine type..................	single-row radial
Number of cylinders..........	9
Cooling......................	air

Order of numbering of cylinders	clockwise, looking at the engine from the crankcase rear cover and considering the top cylinder as the first
Diameter of cylinder, mm	155.5
Piston stroke for cylinder No. 1 with main connecting rod, mm	174.5
Compression ratio	6.4 ± 0.1
Displacement of one cylinder, *l*	3.31
Displacement of all cylinders, *l*	29.87
Direction of rotation of crankshaft	clockwise, if we look from the rear cover
Supercharger	gear-driven centrifugal single-speed
Gear ratio from crankshaft to supercharger impeller	1:7
Reduction gear	planetary type with six cylindrical planetary pinions
Reduction ratio	11:16
Supply of oil to variable-pitch propeller through the reduction gear shaft	two-channel

Engine operating conditions

Takeoff conditions

Ground power, hp	1000
Number of revolutions of the crankshaft, rpm	2200
Boost pressure, mm Hg	not higher than 1050

The engine develops the indicated power, revolutions and supercharging under standard atmospheric conditions (free-air temperature 15°C, pressure 760 mm Hg). At high free-air temperatures or reduced atmospheric pressure the engine at full throttle develops supercharging and power less, but revolutions - greater than indicated. Under conditions of low temperatures the revolutions are less than 2200 per minute, but supercharging and power, - greater than established. In this case the throttles on takeoff should be opened only till the obtaining of maximum permissible boost pressure - 1050 mm Hg. At takeoff conditions it is permitted to continuously operate not more than 5 min to avoid heavy engine overload.

Nominal conditions

Ground power, hp........	820
Number of revolutions, rpm....................	2100
Boost pressure mm Hg....	900 ± 10

At rated altitude 1500 m the engine at the same revolutions and boost pressure developed power 840 hp. According to specifications the engine should reliably operate under nominal conditions continuously not less than 1 h. The loads which appear during operation at nominal rating are calculated for the engine components.

Operating condition

Power..................	0.9 nominal (738 hp)
Number of revolutions, rpm....................	2030 ± 20
Boost pressure, mm Hg..................	830 ± 10

The manufacturer quarantees safe engine operation at the operating conditions for the established lifetime.

Table 12. Cruising conditions.

(1) Крейсерские режимы	(2) Мощность, л. с.	(3) Обороты коленчатого вала, об/мин.	(4) Давление воздуха мм рт. ст.	(5) Расход топлива. кг/ч
0,75 *Ne* ном (6)	615	1920±10	765±15	147,5—157
0,6 *Ne* ном (6)	492	1780±10	680±15	105,5—115,5
0,5 *Ne* ном (6)	410	1670±10	620±15	86—94,5

KEY: (1) Cruising conditions; (2) Power, hp; (3) Crankshaft revolutions, rpm; (4) Air pressure, mm Hg; (5) Fuel consumption, kg/h; (6) nom.

Crankshaft revolution limits

Maximum permissible revolutions of the crankshaft on the ground and in air (not more than 30 s), rpm....................................	2350
Minimum revolutions during steady engine operation at "idling", rpm....................	500

Characteristics

Figure 87 gives the external and throttle characteristics of the ASh-62IR engine.

Figure 88 gives the altitude performance of the ASh-62IR engine.

All data about power, indicated in the characteristics, are provided for conditions of international standard atmosphere.

Temperature conditions of the No. 1 cylinder head, °C

Normal..................	150-205
Recommended.............	165-185
Maximum permissible during operation at takeoff conditions not more than 5 min and at other conditions not more than 15 min........	245
Minimum for good engine response................	120

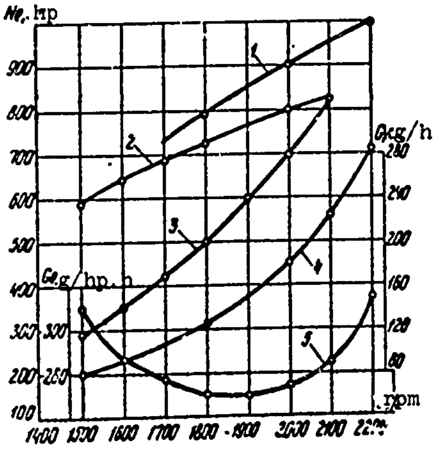

Fig. 87. The external and throttle characteristics of ASh-62IR engine: 1 - External characteristic at full throttle; 2 - External characteristic at P_K = 900 mm Hg; 3 - Throttle characteristic; 4 - Hourly fuel consumption according to throttle characteristic; 5 - specific fuel consumption according to throttle characteristic

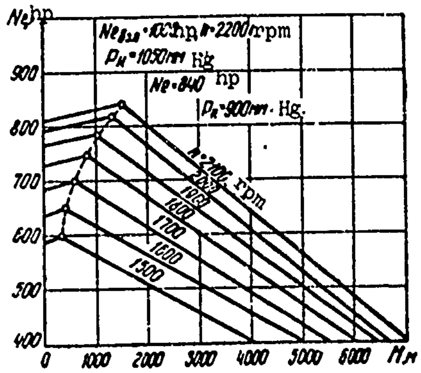

Fig. 88. Altitude performance of ASh-62IR engine.

Fuel feed

Type of fuel..................	gasoline B-91/115 with octane rating 91
Carburetor....................	AKM-62IR
Fuel pump.....................	BNK-12BK
Fuel pressure before the carburetor, kgf/cm^2:	
Under idling conditions......	not less than 0.15
Under operating conditions...	0.3-0.35

Oil feed

Type of oil, used for winter and summer..	MS-20 or MK-22
Oil life, h.............................	100
Oil pump................................	MSh-8
Oil filter..............................	MFM-25

Oil pressure, kgf/cm^2:

a) in oil pump	5-6
b) in crankcase rear cover	4-5
c) at idling conditions at 500 rpm	not less than 2
d) at revolutions 700-800 rpm 10 s after starting the engine	not less than 3

Temperature of incoming oil, °C:

a) minimum permissible	not below 50
b) recommended	60-70
c) maximum permissible not more than 3 min	85

Ignition

Ignition sequence in cylinders	1-3-5-7-9-2-4-6-8
Magneto	two (2) BSM-9
Spark advance in degrees of rotation of the crankshaft:	
a) for right magneto	20° to t.d.c. in the compression stroke
b) for left magneto	15° to t.d.c. in the compression stroke
Spark plugs	SD-48BSM
Spark-plug gap, mm	0.28-036

Mixture distribution

Opening and closing of valves in degrees of rotation of crankshaft:

a) intake valve;	
opening	15° + 10° to t.d.c. in the exhaust stroke
closing	44° after b.d.c. in the compression stroke
b) exhaust valve:	
opening	74° to b.d.c. in the expansion stroke

closing	25° + 10° after t.d.c. in the intake stroke
The gap between the rollers of valve rockers and stems with cold engine, mm:	
a) for checking the correctness of adjustment of mixture distribution (on cylinder No. 1)	1.9
b) for engine operation	0.5
Maximum intake and exhaust valve travel, mm	14.25

Overall size and weight of engine

Diameter of engine with respect to the valve covers, mm	1375^{+5}
The same with respect to valve cover studs, mm	1380^{+5}
Length of engine (without starter and generator), mm	1130
Dry weight of engine (without generator, starter, propeller and the parts for attaching the propeller to the shaft), kg	567 ± 2%

Service life of engine

1. To the first repair, h	1000
2. Service life between repairs, h	800
3. Overall engine life, h	6000

Note. The engine service life between repairs is shown in the engine log.

§ 21. AUTOMATIC PROPELLERS V-509-D9A, AV-7N-161 AND AV-2

Propeller V-509-D9A with Wooden Blades

On An-2 land-based aircraft with ASh-62IR engine there is installed the V-509 automatic tractor propeller with in-flight variable pitch of G. M. Zaslavskiy's design.

The V-509 propeller together with the constant-speed governor R-7F or R-9SM2 within the operating range automatically provides the set engine revolutions, regardless of the change of flight conditions or boost pressure change.

The automation of the propeller is based on the hydrocentrifugal principle with respect to the direct scheme of action and with two-channel feed of oil to the propeller. In propellers of direct action the rotation of blades for increase in pitch is produced by the centrifugal moment of counterweights, and the rotation of blades toward decrease of pitch - under the action of oil pressure.

The transfer of V-509 propeller blades to low pitch occurs under the action of the moment, being created by the pressure of the oil entering the cylinder-piston group of the propeller from the pump of the R-7E governor.

The transfer of blades to high pitch occurs under the action of the sum of the moments, created by:

1) centrifugal forces of counterweights;

2) pressure of oil entering the cylinder-piston group of the propeller from the pump of the R-7E governor.

The V-509 propeller has two characteristics. The first feature consists of the fact that with lowering of pressure in the oil line, proceeding from the governor to the propeller, the propeller under the influence of the moment being created by centrifugal forces of counterweights increases the pitch and is balanced to the revolutions of cruising conditions, which allows continuing further flight of the aircraft. Counterweights are selected in such a way that the centrifugal forces acting on them will create a moment, always larger than the moments acting on the blades from aerodynamic and centrifugal forces, which strive to turn the blades toward decrease of pitch.

The second feature of the propeller is that for preventing the thickening of oil in the cylinder-piston group of the propeller, in endurance flights under conditions of low temperatures of the surrounding atmosphere, in the wall of the large travelling piston there is a (jet) hole with diameter 0.8 mm, connected to the cavity of high and low pitch, by which constant oil circulation is provided from the low pitch cavity to the high pitch cavity. Because of this, there occur periodic loading of the propeller and constant inflow of warm oil from the engine into the cylinder-piston group of the propeller.

On aircraft up to the 129 series the manufacturer of An-2 aircraft installed V-509A-D7 propeller with swept-back blades.

For increasing the serviceability and raising the operating life of the propeller on aircraft from the 129 series the plant installs a V-509-D9 propeller instead of V-509A-D7. The V-509-D9 propellers have rectangular (oar-shaped) blades. The V-509-D9 propeller is completely interchangeable with the V-509A-D7 and additional modifications of the aircraft are not required during replacement of the propeller.

During operation of the aircraft with the V-509-D9 propeller there were cases of the failure of D9 blades. The basic reason for the failure of D9 blades is the loss of strength of glued joints.

The manufacturer of the propellers manufactured D9A blades instead of D9 blades, which have high vibration strength. However, during operation of propellers with D9A blades defects similar to D9 blades appear.

Therefore for An-2 aircraft the propeller manufacturer designed and series produces the type AV-2 propeller with metal blades, more reliable in operation.

The V-509-D9A propeller is operated only at aircraft concerns located in the north of our country.

The main components of the V-509-D9A propeller are four wooden blades and the propeller hub. The propeller hub consists of a steel nonremovable casing, boss, guide, cylinder unit, four blade seats and four counterweight units.

Basic technical data of propeller with D9 and D9A blades

Type of propeller	tractor, automatic, in-flight variable pitch	
Operating principle	hydrocentrifugal	
Scheme of action	direct, with two-channel oil feed.	
Direction of rotation of propeller	right	
Propeller diameter, m	3.6	
Number of blades	4	
Blade characteristic:		
index	D9A	D9
material	pine, hot-pressed resin plywood with veneer covering and steel tipping	pine, hot-pressed resin plywood with veneer covering and steel tipping
Shape of blades	rectangular with small contraction toward the end of the blade foil	rectangular (oar-shaped)
Profile	Clark "ν"	Clark "ν"
Maximum width, mm	314	290
Relative thickness at $\nu = 0.9R$	0.078	0.060

Efficiency factor*	127	127
Design efficiency of propeller under conditions $V_{\text{макс}}$	0.77	0.77
Design inertia moment, kgf·cm·s^2	354	302
Natural vibration frequency, Hz	20	14.5
Blade weight, kg	19.8	18.7
Blade angle at R = 1000 mm:		
minimum	13°30' ± 10	13°30' ± 10
maximum	28°30' ± 2°30'	28°30' ± 2°30'
Counterweight angle	20°	20°
Guaranteed service life of blades, flying hours	750	700
Governor	R-7E or R-9SM2	R7E or R-9SM2
Propeller weight, kg	176.9 + 2%	172.5 + 2%

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*Propeller efficiency factor (English meaning) is a very important index of the planform of the blade. The efficiency factor (a dimensionless quantity, conditionally designated AF) characterizes the effective area of the blade and the absorptivity of the engine power by the blade. Narrow blades have AF = 60-80, wide (especially rectangular type) - 120-140. The efficiency factor began to be used for the first time in our literature in the works of Central Institute of Aerohydrodynamics [TsAGI) (ЦАГИ) No. 429, published 1939. (Belkin and Druzhinin. "The practical method of calculation of propeller characteristics").

AV-7N-161 Propeller with Metal Blades

The V-509-D9A propellers, having wooden blades, do not completely satisfy the operating conditions and therefore are replaced by AV-2 propellers with metal blades.

On the basis of the test data of the State Scientific Research Institute [GosNII] (ГосНИИ) of civil aviation, in the operational concerns of Aeroflot since May 1963 there has been permitted the operation of An-2 aircraft in the transport version with AV-7N-161 propellers. The modification of AV-7N-161 propeller for its utilization on An-2 aircraft involves only the replacement of range ring 9 mm high by a 60 mm range ring, which limits the travel of crosspiece of the propeller on the high pitch stop and thereby prevents the blades from entering the feathering pitch.

The modified propellers have a mark in the form of a blue transverse band on one of the blade seats of the propeller casing. Such propellers are intended for operation on An-2 aircraft only with the R-9SM2 speed governor.

The installation of AV-7N-161 propeller on An-2 aircraft very insignificantly affects the technical and flight characteristics of the An-2 aircraft: horizontal speeds are increased 5-6 km/h, and in horizontal flight under cruising conditions of engine operation the hourly fuel consumption will increase a little.

The position of the center of gravity of the aircraft, takeoff and landing characteristics and the rates of climb of the aircraft remain practically unchanged. The AV-7N-161 propeller works together with the R-9SM2 speed governor in a bilateral scheme.

The main components of AV-7N-161 propeller are the casing, blades, crosspiece, cylinder and FSh-1 pitch stop.

Basic technical data of propeller

Type of propeller...........	tractor, automatic, in-flight variable pitch
Operating principle of propeller gear..............	hydrocentrifugal
Operating scheme of the propeller gear..............	double
Direction of rotation of propeller................	right
Diameter, m.................	3.6
Number of blades............	3
Maximum blade width, mm.....	292
Relative blade thickness at r = 0.9R................	0.052

Aerodynamic series	61F
Efficiency factor	90
The type of profile of section	F
Blade angle at radius R = 1000 mm:	
minimum	19° ± 15°
maximum	44° ± 2°
feathering	90°30' - 1°
Total turning range of blades	71°30'
Design inertia moment of propeller, $kgf \cdot cm \cdot s^2$	527
Number of the blade	0161-05-G
Blade material	duralumin D-1
Propeller weight, kg	176 + 2%
Hub weight, kg	88
Propeller governor	R-9SM2
Maximum oil pressure developed by governor, kgf/cm^2	35 ± 2
Life of propeller to the first overhaul, h	1300
Operating life of propeller between repairs, h	1000
Serviceable operating life, h:	
hub	9000
blades	3300
Guaranteed storage life in mothballed state, years	2

AV-2 Propeller

The four-bladed propeller AV-2 is designed for operation with the ASh-62IR engine on An-2 aircraft.

The AV-2 propeller, interconnected with the constant-speed governor R-9SM2 or R-7E, automatically maintains the set constant engine rpm because of change of the propeller blade angle under any operating conditions of the power plant.

The hydraulic propeller pitch setting mechanism is carried out by the bilateral scheme of action. The transfer of blades to high pitch proceeds under the action of the pressure of oil, fed into the cylinder of the propeller from the speed governor pump, centrifugal forces of counterweights, installed on the jackets of the blades, and aerodynamic forces of the blades.

The transfer of blades to low pitch is produced under the action of oil pressure and lateral components of centrifugal forces of the blades.

The moments created by counterweights during propeller operation are greater than moments from lateral components of centrifugal forces of the blades. Therefore, in the case of break of the governor drive or oil pressure loss in the oil line leading to the propeller the moment excess turns the blades to increase in pitch and with this the propeller is balanced for revolution of the cruising conditions of engine operation, which allows continuing further flight of the aircraft.

The variation of the propeller pitch within operating limits can be accomplished automatically by the constant-speed governor and by the forced method with the aid of the propeller pitch quadrant located on the central panel and in the cockpit.

Basic technical data of AV-2 propeller

Type of propeller...........	variable-pitch propeller
Operating principle.........	hydrocentrifugal of bilateral action with balanced blades.
Type of propeller...........	tractor
Direction of rotation.......	right (looking from the engine)
Propeller diameter, m.......	3.6
Number of blades............	4
Blade material..............	aluminum alloy D-1

Blade drawing number	0389-01
Relative thickness of tip section of blade	0.055
Maximum blade width, mm	284
Blade profile	F
Aerodynamic series of blade	AV-72-91B
Design inertia moment, $\text{kgf}\cdot\text{cm}\cdot\text{s}^2$	678
Blade angles at R = 1000 mm:	
a) minimum blade angle (starting angle)	17°
b) maximum blade angle	32°
Turning range of blades	15°
Counterweight angle	30° ± 1°
Static moment of counterweight unit, gf·m	411.7 ± 3
Propeller revolutions (maximum) rpm	1510
Propeller weight, kg	192 + 2%

The structural distinctions of AV-2 propeller of series 02 from AV-2 propeller of series 01. Today in operation is the AV-2 propeller of series 02, which is a further improvement of the AV-2 propeller of series 01 and is intended for operation with the ASh-62M engine with three-channel feed of oil from the engine to the propeller.

The AV-2 propeller of series 02 has the following structural distinctions from the AV-2 propeller of series 01:

1. In connection with the introduction to ASh-62M engines of a drain channel, which connects the cavity of the propeller hub with the crankcase of the engine reduction gear, in the AV-2 propeller of series 02 the high pitch cavity is separated from the propeller hub cavity, which guaranteed the relieving of the operating pressure of oil with seals of sleeves of the casing.

2. The separation of the high pitch cavity from the propeller hub cavity caused a change of the piston, diaphragm and gasket of the oil overflow connection, in which there are three openings for the drain channel.

3. There is introduced insulation of the propeller cylinder instead of the propeller hub spinner (as compared with propeller V-509-D9). In connection with the introduction of insulation the locking hub part No. 2-267 is replaced by locking hub part No. 2-293.

4. Protective fluroplastic rings are introduced to rubber seals RU-11R on the piston and RU-197R on the diaphragm.

Guaranteed life, calendar operating life and storage life of AV-2 series 02 propellers. Considering the cumulative experience in the operation of AV-2 propellers on AN-2 aircraft, AV-2 series 02 propellers from No. 6504V01 and from No. 72001 are released with guaranteed life 2000 h.

For all manufactured AV-2 and AV-2 series 02 propellers guaranteed life 2000 h has been established.

The calendar operating life of propellers is 6 years. The storage life in the special packing of the supplier: at the warehouses of customers - 5 years; on open areas - 3 years; at the consumer plants - 1 year.

§ 22. ENGINE MOUNT

The engine mount (Fig. 89) is a space truss of welded construction, which consists of eight struts and a ring with engine mounting lugs.

The base of the mount is a ring with nine engine mounting lubs welded to it. The ring is made from 30KhGSA steel and is heat

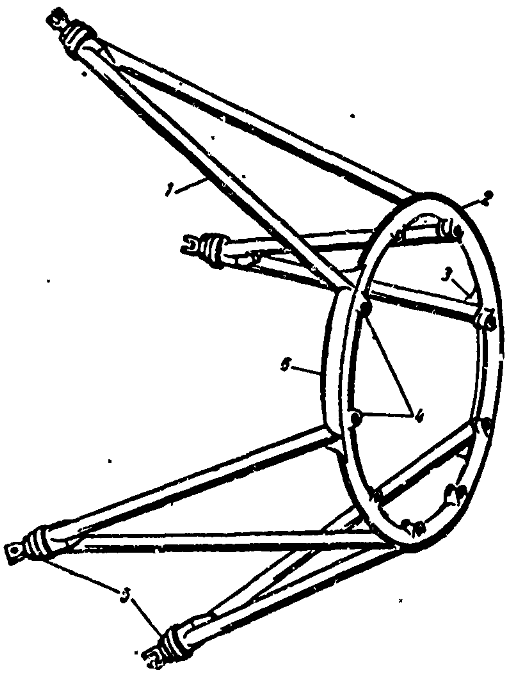


Fig. 89. Engine mount: 1 - struts; 2 - ring; 3 - knee plate; 4 - engine mounting lugs; 5 - mounting lugs of mount to the fuselage; 6 - reinforcing plate.

treated to $\sigma_{вр} = 80 \pm 10$ kgf/mm^2, the mounting lugs of the engine to the mount are made from 30KhGSA steel and are heat treated to $\sigma_{вр} = 100 \pm 10$ kgf/mm^2.

To the ring of the mount there are arc welded eight struts arranged in pairs. The tubes of the struts are made from 30KhGSA steel and are heat treated to $\sigma_{вр} = 120 \pm 10$ kgf/mm^2.

At the places of welding of the struts to the ring there are placed reinforcing plates in the form of a knee plate and a box, made from, 20A steel.

Each two struts by their other ends are welded to the sleeves of the mount, in which rubber shock absorbers are mounted.

During operation there were observed cases of the appearance of cracks in the upper struts and in the ring of the mount. For eliminating this defect reinforcement is produced by increase in the wall thickness of the ring and the diameter of the upper struts, and also the welding of the mount lugs is improved. Furthermore, on aircraft from the 139 series reinforcement of the engine mount is produced by welding boxes instead of knee plates in the area of joining of struts to the mount ring.

However, despite the performed reinforcement, on engine-mountings as before there appear cracks of the ring, struts and reinforcing plates.

In operational subdivisions it is necessary to strictly adhere to systematic fulfillment of bulletin No. 30900152 on the removal of engine vibration and not permit flights of An-2 aircraft with engine vibration.

The engine is fastened to the mount with nine studs 12 mm in diameter made from 30KhGSA steel.

The mounting lug of the engine to the mount is shown in Fig. 90 and consists of stud bolt 1, shock absorber 2, sleeve 4, ring 3, washer 8, nut 9.

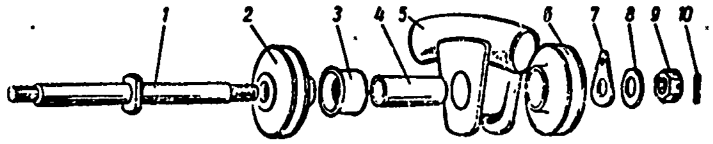


Fig. 90. Mounting lug of the engine to the mount: 1 - stud bolt; 2 - shock absorber; 3 - ring; 4 - sleeve; 5 - engine mount lug; 6 - shock absorber; 7 - metallization washer; 8 - washer; 9 - nut; 10 - cotter pin.

The engine mount is bolted to the fuselage lugs by four bolts made from 30KhGSA steel.

For damping the engine vibration in each mounting lug of the mount to the fuselage there are placed rubber shock absorbers. The shock absorber (Fig. 91) consists of four rings 2, placed on hollow rod 3, which by its inner thread is connected to forked bolt 5 for attaching the mount to the fuselage.

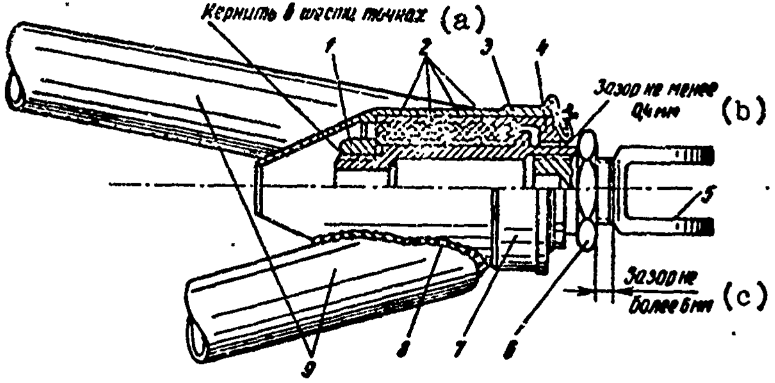


Fig. 91. Shock absorber; 1 - rod nut; 2 - shock absorber ring; 3 - rod; 4 - special nut; 5 - forked bolt; 6 - lock nut; 7 - sleeve of mount; 8 - weld; 9 - struts.

KEY: (a) Center punch at six points; (b) Clearance not less than 0.4 mm; (c) Clearance not more than 6 mm.

Each ring consists of two concentrically arranged steel rings, between which there is cured in a layer of shock-absorbing rubber. The rings are pressed on a rod by a nut. The assembled pack is placed in the sleeve of the engine mount, the upper rings of which are pressed in the sleeve between the side inside the sleeve and by a special nut, screwed into the sleeve of the mount. The forked clamping bolt for the engine mount to the fuselage is screwed into the rod and locked with a lock nut.

During operation deficiencies were revealed in the work of the shock-absorbing packs. As a result of the large settling of shock absorbers there were cases of direct impact of the metal parts of the shock-absorbing packs against each other.

On aircraft from the 57 series there is installed improved shock absorption (Fig. 92) of the attachment joints of the engine attachment frame. New shock-absorbing packs possess large reserve of motion and less settling. Furthermore, on aircraft from the 57 series on the fuselage there are installed new, improved mounting lugs of the mount to the fuselage.

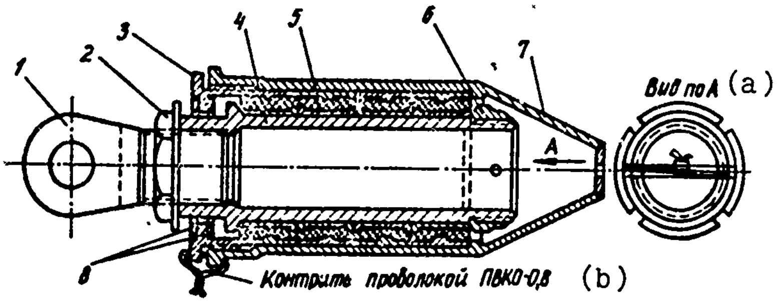


Fig. 92. Shock absorber of mount, installed on aircraft from the 57 series: 1 - forked bolt; 2 - lock nut; 3 - tightening nut; 4 - rod; 5 - shock absorber; 6 - stop; 7 - sleeve of mount; 8 - washers, glued with No. 88 glue.

KEY: (a) View along A; (b) Safety with PVKO-0.8 wire.

During the next aircraft repair it is necessary to replace the old shock-absorbing packs of the attachment joints of the engine attachment mount with new, improved packs.

On aircraft of the latest manufacture there is installed the modernized M6400-0 mount (Fig. 93a). The ring of the mount is stamped out from AK6 alloy and is bolted to the steel rods of the mount (Fig. 93b).

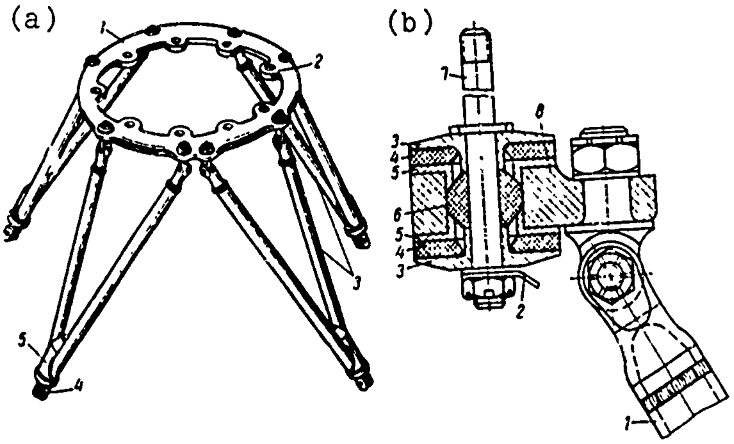


Fig. 93. Modernized mount and engine mounting lug: (a) modernized M6400-0 mount: 1 - ring of mount; 2 - engine mounting lug; 3 - rods; 4 - forked bolt; 5 - damper; (b) engine mounting lug to the ring of the mount: 1 - rod of mount; 2 - metallization cross piece; 3 - washer; 4 - rubber shock absorbers; 5 - bushings; 6 - rubber ring; 7 - bolt; 8 - ring of mount.

§ 23. PROPELLER SPINNER AND ENGINE COWLING

The propeller and the engine, installed on aircraft, are enclosed in cowlings, which consist of the external and inner engine cowling and the propeller spinner (Fig. 94).

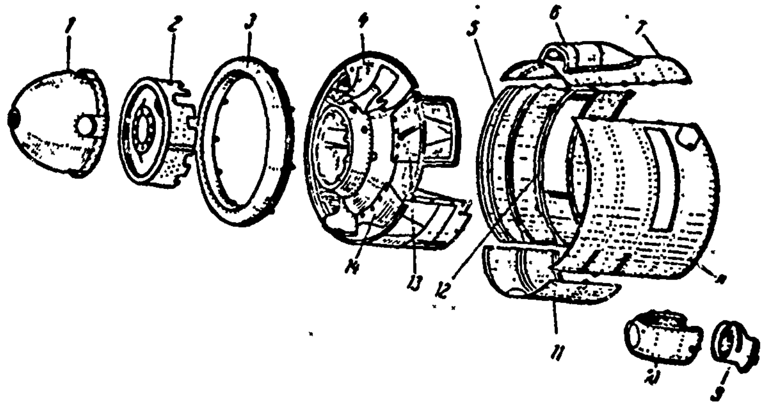


Fig. 94. Propeller spinner and engine cowling: 1 - propeller spinner; 2 - engine crankcase cowling; 3 - front ring; 4 - inner cowling; 5 - right side cover of external cowling; 6 - air intake cowling; 7 - top cover; 8 - left side cover; 9 - casing of oil cooler with flaps; 10 - oil cooler duct; 11 - bottom cover; 12 - support; 13 - upper duct with shutters of the cowl flap; 14 - lower duct with shutters of the cowl flap.

Propeller Spinner

On the V-509 propeller hub there is installed an easily removable spinner, consisting of the removable part, spinner disk and the engine crankcase cowling.

The detachable part of the spinner has a stamped shell of AMtsAM alloy 1.5 mm thick, front support of D16T duralumin, edging of cutouts at the blade root made of steel 20A 1.5 mm thick, and duralumin sections of annular shape with pins. All elements on the shell are assembled on rivets.

The disk (rear support) of the spinner consists of a disk made of duralumin 2 mm thick, locking ring with cutouts for pins, made from steel 1 mm thick, covering made of AMtsAM alloy 1.5 mm thick and cover plates with angles under the root cutouts, made of duralumin 1 mm thick.

All elements of the spinner disk, except the locking ring, are assembled on the disk by rivets. The assembled spinner disk is mounted to the twelve bolts of the propeller hub and is fastened with castle nuts.

On the disk is installed the detachable part of the spinner and is locked on the pins with locking rings. The ring is locked with a clip, installed on the disk, and by a stop, installed on the locking ring. The clip and the stop of welded construction are made from carbon steel.

Besides attachment of the spinner to the disk, its detachable part has a front support, installed on the cylinder of the propeller. The support is a hollow turned rod of steel 45 with a flange for attachment to the propeller cylinder by six bolts.

The manufactured spinner is balanced by a counterweight made of steel 20A, which is riveted to its disk.

In order to remove the detachable part of the spinner, it is necessary with a screwdriver to unlock the stop catch and turn the locking ring, thereby having freed the detachable part of the spinner from the holding of the pin.

The propeller spinner with the crankcase cowling provides protection of the propeller hub and the engine reduction gear nose from overcooling. For easing the access to the forward section of the engine the crankcase cowling is made easily removable, on "Dzus" type clips.

During operation cracks appeared in the detachable part of the spinner and its disk, and there also were cases of separation of the spinner from the rear support of the disk in air.

For prevention of breakage of the propeller spinner the propeller spinner is reinforced by placing external cover plates in the area of cutouts under the propeller blades and an additional stiffening rib is introduced on the inner cover plates.

For the elimination of caulking the diameter of the hub and the rubber ring in the forward section of the spinner has been increased 5 mm.

When installing the detachable part of the spinner it is necessary to keep reliable connection of the pins of the spinner with the locking ring of the disk.

External Engine Cowling

External cowling has conical shape and its dimensions enter the contour of the fuselage, forming together with it the overall streamlined shape of the aircraft.

The external cowling is the power plant cowl. It covers the engine and oil cooler and thereby reduces aircraft drag.

The external cowling consists of a front ring, top cover, two side covers, bottom cover and oil cooler duct.

The front ring of the cowling is a shaped closed section receiving the aerodynamic load appearing on its surface. The ring consists of ribs, inner and outer covers of duralumin 0.8 mm thick and annular sections. The front ring with the aid of brackets with rubber shock-absorbing sleeves is bolted to the eyes of the valve covers of the engine. The brackets are bolted to the annular section.

For preventing stresses during installation at the points of attachment of the front ring of the cowling to the engine cylinders there are installed adjusting washers with bolts.

The front ring of the cowling has internal boxes. On the attachment boxes of the ring to the engine cylinders the oval openings for approach to the attachment nuts of the ring hinge brackets are removed and are transfered from the box to the covering.

The covers of the cowling are easily removable, of lightened type, not bearing loads, and have insignificant longitudinal and lateral stiffening assembly.

The cowling consists of four covers: top, right side, left side and bottom. The covers are riveted from duralumin plates 0.8 mm thick, transverse U-shaped bent sections, and longitudinal pressed angle sections, located along the edge of the covers.

On the top cover there is a cutout under the intake pipe and the cold air intake of the carburetor. The air intake cowling is fastened to the top cover by rivets and has a removable part, which is fastened to the air intake cowling on "Dzus" type spring catches. Inside the air intake is installed a gauze dust filter, which is turned on and off by a quadrant from the cockpit.

In the rear of the air intake cowling is mounted the backfire valve.

On aircraft up to the 35 series on the rear section of the top cover there are riveted two reinforcing steel cover plates with tubes, into which fit the pins installed on frame No. 1 and which fix the position of the top cover.

From the 8th machine of the 35 series the top lid is joined with fuselage frame No. 1 by means of rubber shock absorbers. The top lid is bolted to the baffle of the inner cowling with two bolts with wing nuts. On each longitudinal section of the cover on the right and left side there are riveted unit steel loops, five on each side for attaching the side covers. The top lid rests with its front U-shaped section in the groove of the front ring of the cowling.

From the 13th machine of the 36 series on the top lid there is installed a hatch for access to the filler neck of the oil tank, in connection with the installation from this series of aircraft of a lightened and better construction of the oil tank.

From the 11th machine of the 158 series the inner skin of the cowling of the top lid of the cowl is reinforced by the installation of two stiffening sections and from the 162 series on the skin are introduced three stiffening grooves.

Modification on the reinforcement of the inner skin of the air intake of the top lid of the cowling on aircraft up to the 10th machine of 158 series is performed according to bulletin No. 30200291.

To avoid cracks from the 162 series the Cardan joints of the upper cowl flaps are reinforced.

On the upper sections of the side covers there are installed L-shaped pins for suspending the covers to the top lid components. On both side covers cutouts are made for the upper cowl flaps; the longitudinal edges of the cutouts are supported by bulb sections. On the right cover there is installed the exhaust pipe cowling with the cold air intake of the cabin heating system of the fuselage.

On aircraft up to the 13th machine of the 36 series in the upper rear end of the left side cover there is a hatch hole for access to the filler neck of the oil tank.

For convenience of use of the oil drain cock on aircraft from the 100 series a hatch is installed on the left cover of the cowling.

Sections in the bottom part of the side covers end in steel reinforcing clips, into the boxes of which are screwed threaded sleeves for the installation of cowl latches.

The side covers are held in the open position by tubular supports. If necessary the side covers can be removed from the top lid, by rocking and moving them forward in flight.

The bottom cover is somewhat shorter than the side covers. Steel boxes reinforce the ends of the sections of the bottom cover. Into the boxes are screwed threaded sleeves for the installation of three lever cowl latches. Along the axis of the bottom cover there are installed two hatches: front - for draining oil from the oil sump of the engine, rear - for feeding the engine preheating hose of the oil tank.

On aircraft from the 85 series on the bottom cover of the cowling there is additionally installed a second hatch for preheating the engine on the ground.

To the longitudinal sections of the top lid as well as to the bottom longitudinal sections of the side covers there are attached gaskets of "Flak" fiber, sealing the junction of the covers and protecting sections from abrasion.

The covers lie with their cross sections on the sections of frame No. 1, inner cowling and on the front ring. The covers are kept from axial movement and determine the external outline of the cowling with tightening of the latches. After closing the latches the latch handles are locked with catches. The slot of the catches under a screwdriver in the closed position of the latch is located parallel to the axis of the aircraft.

The difference in the vibrations of the power plant and airframe during engine startings, and also at all engine operating conditions on the ground and in flight leads to wear of the parts of the power plant cowl. During operation in the cowlings of the power plant, air scoop, dust filters and the propeller spinner cracks appear because of this.

For elimination of this defect the design of a new modernized cowling has been developed, and a dust filter of new construction has also been created.

Oil Cooler Duct

The oil cooler duct - riveted-welded construction, consists of a skin made of AMtsAM and D16T alloy, and profiles of sheet D16AT duralumin 1.5 mm thick.

The forward section of the duct for the inlet of air is a shaped opening in the form of a funnel, which on one side is welded to the covering of the duct, and the other is riveted together with the cross section.

In the top part of the duct two sections are attached, on which there are installed wedge-shaped keys for mounting the duct to the cooler frame. In the rear end of the duct on the skin, reinforced by a section, there are installed two eyes with bolts and wingnuts, serving for the combined attachment of the duct and housing of the oil cooler. Along the upper edge of the duct there is attached a felt gasket for sealing and protecting the skin of the duct from work hardening and wear.

In the bottom part of the duct there is installed a hatch for draining the oil from the cooler.

The oil cooler housing with controllable flaps serves for changing the air flow velocity, passing through the cooler during oil cooling with the engine operating.

The housing is made from D16AT duralumin. On the right and left walls of the housing are attached brackets with lugs for sleeves under the flap hinges. In the upper part of the housing on bolts there is installed a bracket, directing the axle of the hinge. On the axle is mounted the sector of the oil cooler flap and the rod of the sensor of the oil cooler flap position indicator is fastened to it. On this bracket there is bolted the UR-7 mechanism, which with the aid of a bevel gear and leverage actuates the housing flap.

The UR-7 mechanism is additionally fastened to the housing with a band.

The sensor of the oil cooler flap position indicator is installed on the bracket, attached to the fuselage skin between frames Nos. 1 and 2.

The oil cooler flaps are made from D16AT duralumin 2 mm thick, to them are attached hinges, serving as axes of their rotation.

The hinges are connected together by a link. The last hinge is connected with the bevel gearing.

In the end of the forward section of the housing there is attached a felt gasket for sealing and shock absorption of the junction of the housing with the oil cooler.

The housing is bolted to the fuselage with the aid of two brackets.

Inner Engine Cowling

The inner engine cowling separates the forward section of the engine and exhaust manifold from the rear end with the engine components.

The inner cowling has the shape of truncated cone and consists of a baffle, four ducts and the mounting frame of the oil cooler.

The baffle is a shaped partition of riveted construction, consisting of four parts of skin, front reflector and sections. The skin, reflector and bent sections are made from sheet duralumin 1.5 mm thick. The section, installed near the exhaust pipe, is made from YalT steel.

In the baffle a cutout is made under the exhaust pipe and edged cutouts are made under the ventilation tubes of engine components and the oil sump.

The baffle is bolted to the ring of the mount on nine attachment bolts of the engine to the mount and is additionally supported by two rods, fastened to eyelets of the engine cylinders.

In the bottom part of the baffle there is attached the warm air intake for preheating the engine on the ground. The air intake is made from AMtsAM alloy 1 mm thick. On the latest series of aircraft the air intake has a cover.

The baffle has cutouts under the installation of the four ducts with flaps for engine cooling and is connected by the mount to fuselage frame No. 1. The mount consists of two pressed sections, connected together with a duralumin cover plate and the mounting saddle of the oil cooler. The saddle consists of a shackle, on the ends of which are attached steel eyes with openings under the attachment of the cooler strips. The saddle is attached to the sections with the aid of steel boxes.

Cutouts are made in the sections for attaching the oil cooler duct with the aid of wedge-shaped keys, which are bolted to the sections. The bottom ducts are fastened to the sections and inner cowling clips by "Dzus" type retaining springs and are the continuation of the bottom cover to frame No. 1.

The clips are steel and duralumin boxes installed on frame No. 1, to which are attached mounting bolts and pins of the bottom duct of the cowling.

On aircraft from the 34 series the mounting frame of the oil cooler is separated from the baffle and fuselage frame No. 1 by means of rubber shock absorbers. The bottom cover of the duct is separated from frame No. 1 by the same rubber shock absorbers.

The longitudinal section of the inner cowling is fastened to the baffle with screws and to frame No. 1 - with pins in rubber shock absorbers for decrease in vibration of the power plant.

The cowl flaps serve for adjustment of the amount and velocity of the air flow, cooling the engine cylinders. The cowl flaps are located in the lower and upper part of the engine cowling.

The bottom cowl flaps consist of two ducts and six flaps. In each duct there are mounted three flaps. The ducts are made from sheet duralumin D16AT. Cutouts are made in the ducts for the passage of flap control rods. The cutouts are closed by sealing covers attached to the ducts. The first duct has a removable hatch for access to the oil drain tubes. The flaps in the closed position are hermetically sealed by a rubber strip, attached to the ducts.

The flaps - riveted construction, are made from sheet duralumin D-16AT and are connected to each other with a universal joint. Flaps are installed on a removable section with the aid of eight bearings and are bolted to the section. The section is fastened to the steel knees of the baffle with countersunk screws.

The top cowl flaps, as the bottom, consists of two ducts and six flaps.

The top ducts are smaller than the bottom. Ducts are fastened to the baffle with "Dzus" type retaining springs. A section is attached to the duct with the aid of a steel cover plate. To the section in each duct there are bolted four brackets with flaps attached to them. The construction of flaps, their connection together and with the control rod are similar to the construction of the bottom flap.

For sealing the duct with the cowling covers there are rubber tubes attached to the upper rim of the duct.

During engine maintenance for accessibility to the units the top ducts on the side of the cowl flaps can be disconnected from the baffle, removed and stowed together with the control rods in the brackets installed on the right and left sides on fuselage frame No. 1. In this case it is necessary to unfasten the lock nut of the forked bolt of the rod, since when attaching the flap on frame No. 1 the duct with flaps is turned under the force of its own weight, and the forked bolt of the rod should be drilled. With the installation of skirt flaps in place the lock nut should be tightened with a wrench.

On aircraft of latest manufacture there are installed modernized cowlings Sh69-430 (Fig. 95). The modernized cowling consists of front and rear cowlings, baffle and oil cooler and exhaust pipe cowlings. On the side covers of the cowling there are installed five flaps, which control the amount of air passing through the cowling. All five flaps are controlled by one UR-7M electrical mechanism.

During the operation of modernized cowlings a number of deficiencies has been revealed:

1) the appearance of cracks in bolts and on brackets;
2) settling of Sh69-620 shock absorbers;
3) insufficient ventilation of exhaust pipe;
4) the absence of coupling of UR-7M electrical mechanism.

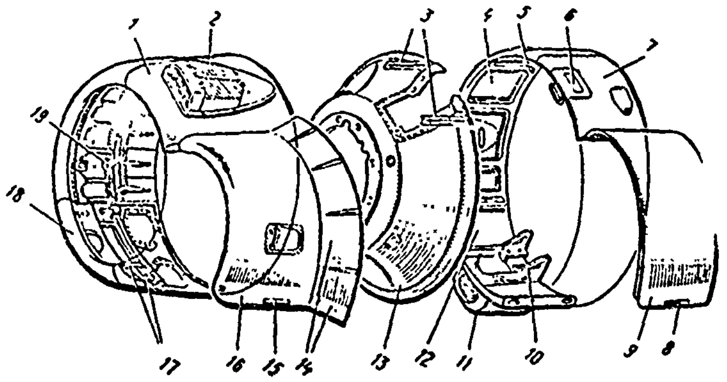


Fig. 95. Modernized engine cowling M69-430: 1 - top lid of front cowling; 2 - air intake of carburetor; 3 - bracket of inner cowling; 4 - right cover of rear cowling; 5 - support; 6 - outlet for gases during backfire; 7 - top lid of rear cowling; 8, 15 - cowling latches; 9 - left cover of rear cowling; 10 - oil cooler bracket; 11 - oil cooler duct; 12 - bottom cover of rear cowling; 13 - inner cowling (baffle); 14 - flaps; 16 - left cover of front cowling; 17 - mounting bracket of cowling; 18 - bottom cover of front cowling; 19 - electrical mechanism UR-7M.

[TR. NOTE: Cowlings M69-430 and Sh69-430 are the same. Unable to determine which is right.]

At present there is developed a design of a cowling with lightened side covers.

§ 24. CARBURETOR AIR INTAKE SYSTEM

The carburetor air intake system includes cold air intake, carburetor air scoop, liners and the air scoop of liners.

The cold air intake is located on the top lid of the external cowling and is the cowling of the carburetor air intake stack, attached to the cover of the cowling.

The carburetor air scoop (Fig. 96) - welded construction, consists of base and top (intake stack). To base of the stack,

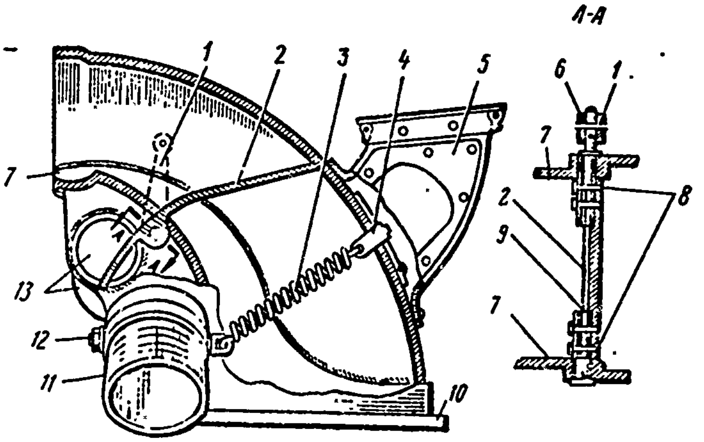


Fig. 96. Carburetor air scoop pipe:
1 - driver; 2 - shutter; 3 - spring;
4 - backfire valve; 5 - branch pipe;
6 - shutter axle; 7 - air intake pipe;
8 - tapered pins; 9 - shutter axle;
10 - flange; 11 - flexible pipe;
12 - bolt; 13 - pipe for removal of
hot air.

cast from AL9, alloy there is welded the top of the stack, made from AMtsAM material 2 mm thick. The air scoop is installed on the top carburetor flange, to which it is fastened with eight bolts, and it serves for feeding heated air into the carburetor of the engine.

The carburetor air scoop consists of the following basic parts: intake stack, air scoop heating casing, shutter, branch pipe of exhaust gases into the atmosphere during backfire and two connecting flanges for attachment of flexible metal hoses.

To the front wall of the intake pipe there is fastened the heating casing with a welded on pipe for the outlet of hot air from the air scoop. Inside the air scoop is installed a shutter, which controls the supply of hot air into the carburetor.

On the rear wall of the intake pipe there is made an opening, intended for decrease in the gas pressure, appearing with backfire through the carburetor. The opening is closed by the shutter, held by a coil spring. For gas removal behind the cowling space on the opening there is installed a backfire pipe with a valve on the top lid of the cowling.

On the left side in the pipe there is a cutout with a bead for attaching the duralumin heating casing of the altitude mixture control. The casing is sectional and is fastened to the bead of the pipe by five screws with anchor nuts. Both halves of the casing are connected together with the aid of a plate and two screws. At the place of exit of the altitude mixture control driver to the casing there is attached a felt gasket for sealing.

On the right side of the power plant, if we look in the direction of flight at the end of the shutter axle coming forward, there is installed the control driver of the shutter of the air duct from the cockpit.

In the housing of the intake pipe there are rubber bearing linings of the shutter axle.

For increase in the service life the brand of the rubber of the lining under the shutter axle of the intake pipe has been changed from VIAM-106 to 1-14.

The preheating of air, which enters the carburetor, in winter is accomplished with the aid of flame tubes, located inside the exhaust manifold. The flame tubes are connected with the air scoop by flexible metal hoses. Such connection is necessary in view of the sharp vibrations of the exhaust manifold and the intake pipe of the carburetor during engine operation.

The preheating of air, which enters the carburetor, in winter is necessary for preventing ice formation in the carburetor chokes. The temperature of the mixture, which enters the engine supercharger, should be within from +3° to +5°C.

Figure 97 shows three possible positions of the shutter:

I - preheating is turned off, only cold air enters the carburetor;

II - preheating is turned on, only hot air enters the carburetor;

III - intermediate position of the shutter, at which cold and hot air enters the carburetor.

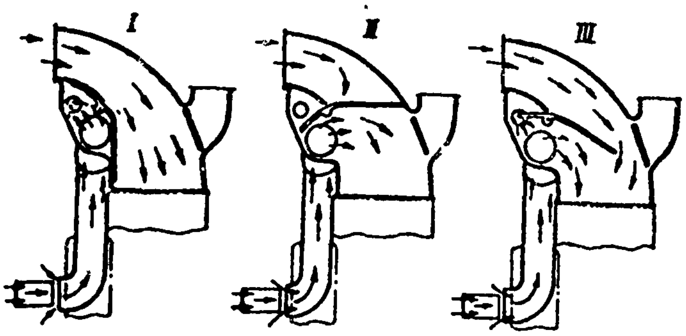


Fig. 97. Diagram of control of air feed into the carburetor.

§ 25. THE EXHAUST SYSTEM

The exhaust system (Fig. 98) includes: the ring of the exhaust manifold, reducer with articulated joint and exhaust pipe. All elements of the exhaust system are made from YalT heat-resistant sheet steel.

The ring of the exhaust manifold consists of eight sections with pipes for attaching to the exit slots of the cylinders. All the sections are connected together by clamps so that between the ends of the sections, after their installation on the engine, there would be a clearance, equal to 2-4 mm.

On each section and clamp on one side there is an annular bead. After tightening the clamps it is necessary to provide clearance between the clamp and the surface of the section along the diameter 0.4-0.7 mm for expansion of the sections during their heating.

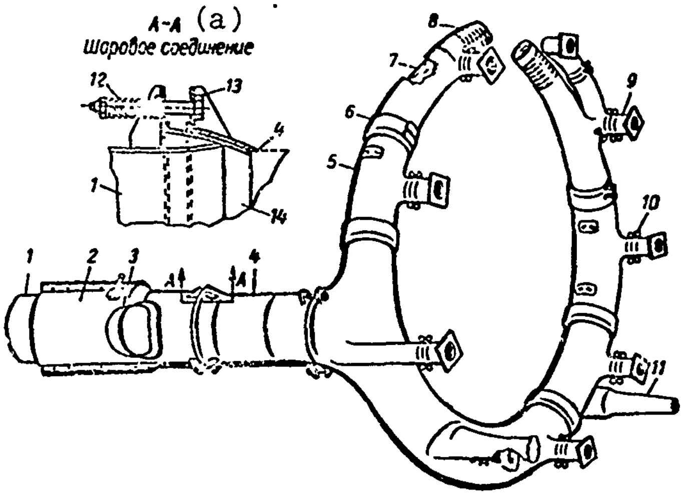


Fig. 98. The exhaust system (exhaust manifold): 1 - exhaust pipe; 2 - heat exchanger jacket (fairing); 3 - cold air intake; 4 - pipe; 5 - section of manifold; 6 - tightening clamp; 7 - flame tube; 8 - flexible hose; 9 - pipe to exit slots; 10 - tightening half-clamp; 11 - air scoop of flame tube; 12 - spring; 13 - bolt; 14 - half-sphere of articulated joint.

KEY: (a) articulated joint.

When clearances do not exist, the brackets of the tightening clamps can be destroyed.

The pipes of the manifold sections are connected to the pipes of the exit slots of the cylinders by tightening half-clamps.

In the bottom part of the manifold there is welded a connection with a plug for the draining of condensate.

Inside the manifold symmetrically to the vertical axis of the engine there are installed two flame tubes, in which the air, which enters the carburetor, is heated. The air scoops of the flame tubes are mounted on the two bottom sections and are directed against the airflow between bottom cylinders Nos. 4-5 and Nos. 6-7 of the engine. The elbows of the air scoops are inserted in the section of the manifold and are connected with the flame tubes by a telescopic joint. The flame tube is supported inside the section by brackets with clamps. The flame heat tubes are connected to the upper sections of the manifold ring with bolts. The flame tubes inside have welded tubes for more rapid heating of air passing inside the flame tubes.

On aircraft from the 106 series for reduction of the temperature of the flame tubes for carburetor air preheating there is introduced a second hot air outlet pipe.

The ring of the exhaust manifold is connected to the exhaust pipe by an articulated joint, which consists of two pipes, inserted one into the other, and six bolts with springs (three springs on each pipe). This connection allows the manifold ring to be moved in different directions without disturbance of the tightness of the joint.

The exhaust pipe is bolted to the side of the fuselage with three bolts by means of brackets, installed on the casing of the heat exchanger of the exhaust pipe and the fuselage.

On aircraft from the 59 series the fastening of the exhaust pipe to the fuselage is reinforced because of the change in brackets and increase in the length of rubber linings and bolts.

On aircraft from the 37 series the exhaust pipe is taken away from the side of the fuselage by 30 mm and for lowering of the air temperature in the cockpit from the 11th machine of the 39 series there is introduced scavenging of the fuselage spouts for the exhaust pipe.

For reduction of the contamination of the side of the fuselage of An-2 aircraft by exhaust gases the exhaust pipe of the manifold is lengthened 100 mm.

Outside along the circumference of the exhaust pipe there are copper soldered ribs of the heat exchanger, which are covered by a jacket, which consists of two halves connected together by bolts and heat-resistant gaskets.

The external part of the jacket has a cold air intake, the inner part of the casing has a mounting bracket of the heat exchanger to the fuselage and a pipe for removal of air from the heat exchanger to the distributor.

The heated air in the heat exchanger proceeds through the distributor into the cargo compartment, the cockpit and to the front glasses of the canopy.

The sections have individual fitting, not allowing the normal replacement of sections from one exhaust manifold by another without the use of negative allowance. During the replacement of sections its branch pipe does not match the pipe attached to the engine cylinder, and the ends of the reinstalled section will be poorly joined with the adjacent sections of the exhaust manifold.

The use of negative allowance causes stress in the other sections and cracks appear on them. However, the start of the formation of cracks can be detected in good time with the attentive inspection of the manifold, for which it is necessary to:

1. Strictly implement the maintenance regulations and after every 300 h of flight remove the exhaust manifold and inspect the flame tubes. During removal of the manifold do not remove the bottom sections between the air intakes of flame tubes and the section with air intakes from the engine, because they are inspected well in place. If on the engine there is installed a manifold of the first category, perform the indicated operations after 600 ± 15 h of flight.

2. Do not allow the exceeding of the amortization service life of flame tubes and sections of the exhaust manifold. Strictly monitor the operating hours of the exhaust manifold and the timely replacement of flame tubes and manifold sections.

The check of the good condition of flame tubes is performed at every test and also after every 300 h of aircraft flight during maintenance with dismantling of the manifold. The flame tube is checked for the absence of cracks by kerosene.

During the engine test with fully activated preheating at revolutions 1800-1900 rpm backfires through the carburetor should not appear. The presence of backfires through the carburetor and sharp drop in manifold pressure to 200 mm Hg is caused by the burnout of flame tubes.

The burned out flame tubes will not be welded and are replaced by new.

The backfires through the carburetor appearing during flight of the aircraft characterize the burnout of flame tubes, in this case it is necessary to land the aircraft to avoid fire in the air.

§ 26. COOLING THE ENGINE COMPONENTS

The engine components - magneto BSM-9, compressor AK-50M and generator GSK-1500 or GSN-3000 - are cooled by cold air during their operation.

The cold air intakes are located in the baffles of the top cylinders and with their funnels are directed against the airflow. On the first series of aircraft there were three cold air intakes: left bottom - for cooling the generator, left top - for the left magneto and right top - for the compressor and right magneto.

For the creation of more intensive cooling of AK-50M compressor on aircraft from the 51st series there is introduced individual cooling of the compressor from the air intake in the baffle, installed between engine cylinders Nos. 3 and 4.

Air from the air intakes along tubes is directed to the components, cools them and exits under the cowling. Air from the generator exits through a line outside the fuselage.

The lines of the component cooling system - welded, made from AMgM alloy and painted black outside.

§ 27. FUEL SYSTEM

The fuel system (Fig. 99) serves for supplying the engine with fuel and consists of six tanks, four-way cock (feed cock), three-way cock (charging cock), sump filter of hand pump RNA-1A (alveyer), fuel pump BNK-12BS, airborne electric light BPK-4 for servicing the aircraft with fuel under field conditions, priming pump (injector), valve for oil dilution with fuel, electrical fuel manometer, electrical fuel gauge, lines, flexible and rigid hoses made of AMgM material with check valves.

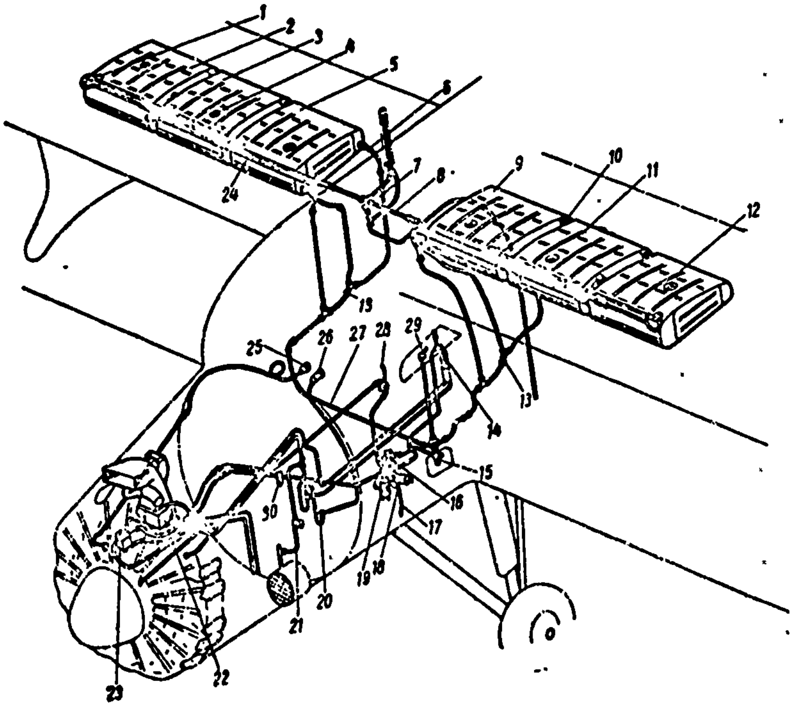


Fig. 99. Fuel system (on aircraft from the 53rd series): 1 - filler neck; 2 - right cantilever tank; 3 - right central tank; 4 - fuel gauge pickup; 5 - right root tank; 6 - flexible hose; 7 - drain cock of drain system; 8 - drain line; 9 - left root tank; 10 - hose joint with check valve; 11 - left central tank; 12 - left cantilever tank; 13 - check valve; 14 - priming pump; 15 - four-way cock; 16 - three-way cock; 17 - drain tube; 18 - fuel pump BPK-4; 19 - sump filter; 20 - fuel pressure transmitter; 21 - magnetic valve EKR-3; 22 - carburetor; 23 - fuel pump BNK-12BK; 24 - system servicing line from BPK-4; 25 - pressure and vacuum gauge; 26 - three-pointer indicator; 27 - feed line; 28 - hand pump RNA-1A; 29 - control handle of four-way cock; 30 - secondary filter.

The schematic diagram of the fuel system is shown in Fig. 100.

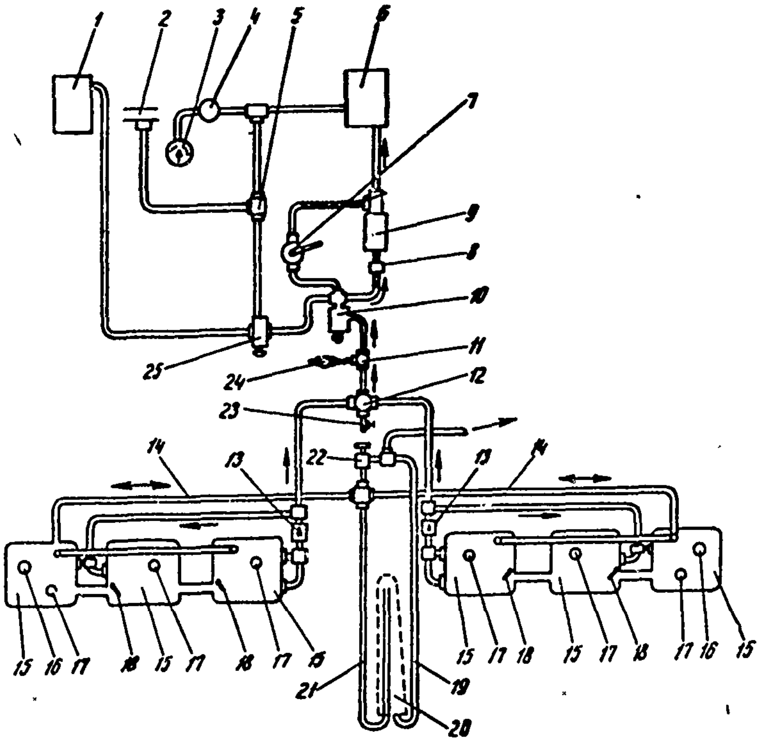


Fig. 100. Schematic diagram of fuel system: 1 - engine cylinders; 2 - oil dilution connection; 3 - three-pointer indicator; 4 - fuel pressure transmitter; 5 - EKR-3 oil dilution cock; 6 - AK-62IR carburetor; 7 - hand pump RNA-1A; 8 - secondary filter; 9 - BNK-12BK engine pump; 10 - sump filter; 11 - three-way cock; 12 - four-way cock; 13 - check valve; 14 - tank drain tube; 15 - fuel tanks; 16 - filler necks; 17 - fuel gauge pickups; 18 - check valves; 19 - tube for draining fuel from radio mast; 20 - radio mast; 21 - tank draining; 22 - cock for draining fuel from drain; 23 - cock for draining fuel from the system; 24 - fuel pump BPK-4; 25 - priming pump (injector).

Fuel tanks (Fig. 101) are located in the upper wing with three tanks in each half wing and are divided into the left and right groups of tanks. Each group has three tanks each: root, central and cantilever. The root and cantilever tanks are identical in volume and have capacity 210 ± 8 *l* each, the central tank is somewhat smaller in volume - capacity 200 ± 8 *l*.

Tanks - riveted and welded construction, are made from sheets of AMtsA alloy. For the stamped bottoms and partitions soft alloy AMtsAM is used, for stiffening sections and shells - semi-cold worked AMtsAP alloy.

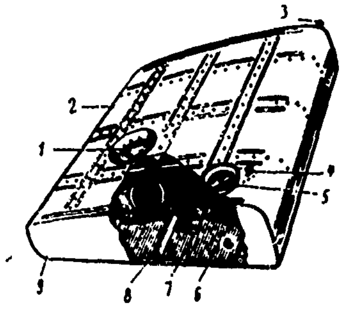


Fig. 101. Fuel tank (right group): 1 - fuel gauge neck; 2 - shell; 3 - connecting fitting for servicing from BPK-4 pump; 4 - drain fitting; 5 - filler neck; 6 - gauze filter; 7 - partition; 8 - stiffening section; 9 - bottom.

Each tank consists of three stamped partitions with lightening holes, six sections 1.5 mm thick, supporting a shell, two bottoms and two shells, welded together. The partitions and sections are fastened to the shells with rivets, the heads of which are rounded by gas welding. On the shells there are grooves for rigidity.

In the root tanks, on the side of the fuselage, there are two connections for the joining of the feed lines of the engine. The location of connections in the front and rear parts of the tank provides total utilization and uninterrupted fuel feed to the engine during climbing and gliding of the aircraft. On aircraft from the 50 series the root fuel tanks are made reinforced from AMtsA material 1.2 mm thick instead of AMtsA 1 mm thick.

During operation there were observed cases of leakage of fuel tanks along welds and rounding of rivets.

For reduction in the cases of the appearance of leakage along the rivets of tanks during operation on aircraft from the 163 series the longitudinal stiffening sections have been removed from tanks (Fig. 102a) and more rigid shells (stamped with "cards," Fig. 102b) have been introduced with change in the brand of material semi-work hardened AMtsAPL1, 2 (on the root fuel tank) and AMtsAPL1 (on the central and cantilever) to annealed AMtsML1, 2.

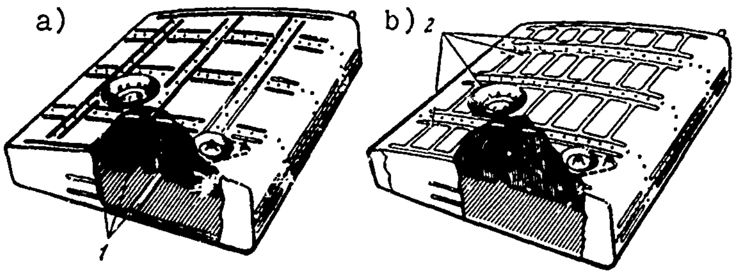


Fig. 102. Fuel tanks of old construction and new, stamped with "cards": a) fuel tanks up to the 162 series; b) fuel tanks from the 163 series: 1 - stiffening sections; 2 - shell, stamped with "cards."

For the timely appearance of leakage of fuel tanks it is necessary to thoroughly inspect them during maintenance of the aircraft.

To the cantilever tanks are welded filler necks. On the cantilever and central tanks there are welded fittings, to which are joined tubes for servicing the system from BPK-4.

All the tanks in the rear part have the fittings with check valves for connection of the tanks together and on top, fittings for the connection of drains, and also seats under the electrical fuel gauge pickups. To each tank there are welded two bolts for the joining of the mesh (cross connection) of metallization. On aircraft from the 51st series the forward section of all tanks in the zone of drain pipes has been lowered.

Tanks after manufacture are tested for vibration and airtightness. The tanks are vibration tested for 30 min with frequency 1100 vibrations per minute at amplitude 0.19 mm. The tanks are tested for airtightness under pressure 0.15 kgf/cm^2. After testing the tanks are painted with yellow A6 enamel.

The tanks are placed in the detachable parts of the upper wing and are installed on the seats of ribs. The root tank is installed on the seats of ribs Nos. 2 and 4, central - on the seats of ribs Nos. 6 and 8 and cantilever - on the seats of ribs Nos. 10 and 12. On the seats of ribs under the tanks there are installed felt gaskets for shock absorption. The tanks are attached to the seats of ribs with duralumin bands, which are tightened by clamps. Under the bands are installed rubber gaskets, protecting the surface of tanks from damage.

After the installation of tanks in the wing their hatches are shut with covers, which are fastened to the sections with screws and anchor nuts. On aircraft from the 38th series there is introduced pressurization, which connects the necks of tanks with the inspection hole on the cover of the fuel hatch. With the introduction of pressurization on the hatch cover there is fastened a sleeve with flange. The sleeve is made from AMts material. On the tank is installed a changed neck, which ensures fitting of the rubber sleeve.

Fourway fuel cock or gate-type feed cock is installed on aircraft up to the 53rd series. On aircraft from the 53rd series there is installed a valve-type cock (item 625,000). The cock serves for shutoff and actuation of feeding fuel to the engine, and also for draining fuel from tanks.

The cock is fastened with three bolts horizontally to the sections installed on the left side of the fuselage between frames Nos. 3 and 4. Access to the cock is possible through the hatch in the forward section of the fuselage on the left side between frames Nos. 3 and 4.

The cock is controlled from the cockpit by a handle, which is connected by a rod to the cock and installed on the left side panel.

Under the control handle of the four-way cock there is installed a stencil with the inscription: "Left open," "Tanks open," "Right open," "Gasoline shut off."

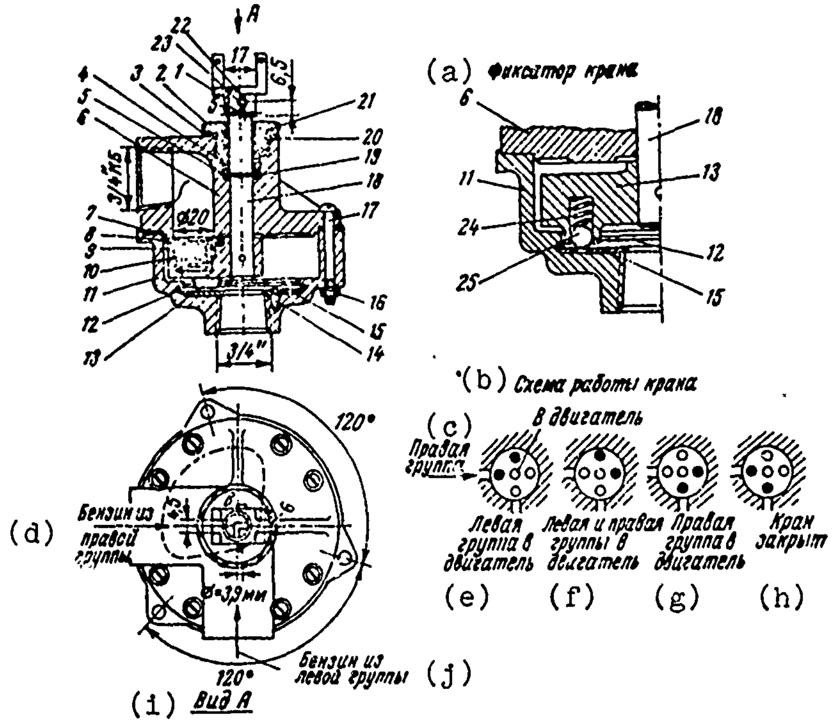
The feed cock (Fig. 103) consists of a housing, housing cover, shaft with bracket, two valves with springs and supporting heads, bracket clamp, clamp latch, shaft spring, eight coupling bolts, rubber gasket and other fasteners.

The housing and covers of the cock are cast from AL4 aluminum alloy. In the cock housing there are two fittings arranged at 90° angle and screwed into the housing on Briggs taper thread, threaded hole under the stuffing box nut, hole for passage of the bracket shaft and two holes 20 mm in diameter for the passage of fuel through the cock from the right and left groups of tanks into the carburetor.

The surface of the housing, to which valves closely fit, has annular recesses for reduction of the wear of friction surfaces of the housing and slide valves. The surfaces of the housing and slide valves are thoroughly ground to get airtightness of the connection.

In the cover of the cock with the aid of annular retaining springs and two pins there is fastened the clamp with four drilled out seats under the ball of the clamp, located in the bracket of the slide valves. The bottom part of the cover has Briggs thread for the connection of the tank fuel drain cock (Fig. 104). The cock has a branch for connection of the line going to the charging cock, and a branch for draining the fuel from tanks.

Inside the housing on a steel shaft with length 88 mm and outer diameter 12 mm with the help of a tapered pin there is fastened the bracket of slide valves, made from AL4 or D1T alloy. Into the openings of the bracket are placed two slide valves, made from 12KhNZA steel, with springs and supporting heads, which are valves, overlapping the openings in the housing 20 mm in diameter with movement of the bracket.


А
22
23
17
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18
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3/4"Т6
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12
13
16
15
14
3/4"
(a) Фиксатор крана
6
18
11
13
24
12
25
15
(b) Схема работы крана
(c) Правая группа
В двигатель
Левая группа в двигатель
Левая и правая группы в двигатель
Правая группа в двигатель
Кран закрыт
(e)
(f)
(g)
(h)
120°
(d) Бензин из правой группы
⌀=39мм
120°
Бензин из левой группы (j)
(i) Вид А

Fig. 103. Fourway valve-type fuel cock: 1 - end piece; 2 - stuffing box nut; 3 - gasket; 4 - spring; 5 - washer; 6 - housing; 7 - gasket; 8 - slide valve (valve); 9 - supporting head; 10 - slide valve spring; 11 - cover; 12 - clamp latch; 13 - slide valve bracket; 14 - pin; 15 - steel plate of clamp; 16 - nut; 17 - coupling bolt; 18 - shaft; 19 - snap ring; 20 - stuffing box washer; 21 - thrust ring; 22 - cotter pin; 23 - bolt; 24 - clamp spring; 25 - ball.

KEY: (a) Clamp of cock; (b) Diagram of operation of the cock in the engine; (c) Right group; (d) Gasoline from right group; (e) Left group in engine; (f) Left and right group in engine; (g) Right group in engine; (h) Cock is closed; (i) View A; (j) Gasoline from left group.

The shaft together with the bracket and slide valves in the pressed position to the ground surface of the housing is held by a spring and washer with the aid of a snap ring, installed on the external neck of the shaft. The shaft in the housing is packed with the aid of a stuffing box with nut.

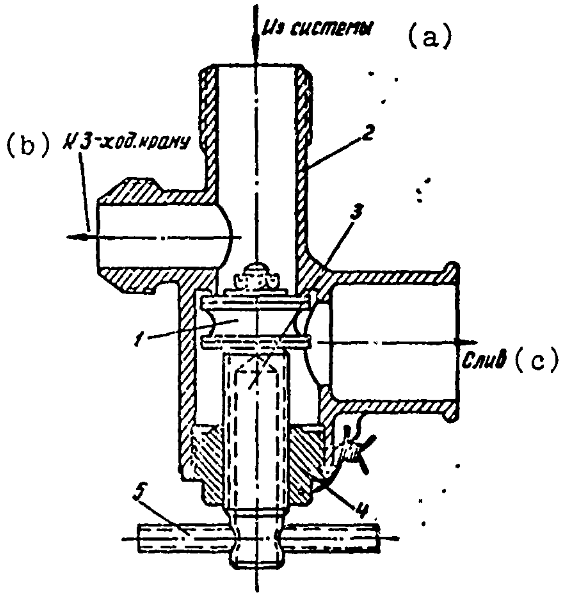


Fig. 104. Tank fuel drain cock: 1 - valve; 2 - housing; 3 - rod; 4 - plug; 5 - tap wrench.

KEY: (a) From the system; (b) To 3-way cock; (c) Drain.

The housing is connected with the cover with eight bolts. For airtightness of the connection between the housing and cover there is placed fuel-resistant rubber packing.

The cock is bolted to the sections of the fuselage frame with three bolts.

The valve-type cock is controlled just as the slide-valve type cock. When turning the cock handle in the cockpit a rigid rod turns the shaft with the bracket and slide valves, which slide across the ground surface of the housing and cover or open the openings in the housing. The diagram of operation of the feed cock is shown in Fig. 103. The position of the cock handle is determined from the stencil.

Use of four-way cock. On the flight line with engine shutdown the cock should be closed. The control handle of the cock should be located in the position "Gasoline shut off" to avoid the overflowing of fuel from group to group in the cock position "Tanks open."

After servicing the aircraft with fuel, regardless of the method of servicing of tanks, it is necessary in 10-15 min, by switching the fourway fuel cock, to drain sediment (0.5-1 l) separately from each group of tanks through the sump filter.

When warming up or when testing the engine check the engine operation alternately on the left and right groups of tanks, switching the fourway fuel cock for a period not less than 1 min.

Perform takeoff and landing with the position of four-way cock "Tanks open." After takeoff and climb to the assigned echelon switch the four-way cock to the right group of tanks and burn off 150 l of fuel, controlling its consumption by the electric fuel gauge. After this switch the cock and fuel gauge switch over to the left group and burn off 150 l of fuel from the left group, then again switch the cock and electric fuel gauge over to the right group and continue to operate until fuel remainder in the tanks is 300 l.

With fuel remainders in the tanks 300 l the cock must be placed in the position "Tanks open," i.e., switch on both groups of tanks.

During operation of the An-2 aircraft there is observed uneven burnoff of fuel from the fuel tanks of the left and right groups.

For preventing the formation of a large difference in the amount of fuel in the left and right groups of fuel tanks from aircraft of the 142nd series on the left instrument panel under the fuel-datum indicator there has been installed a stencil with the inscription "Do not permit difference more than 150 l."

With the execution of flights for aviation-chemical operations the four-way cock is always located in the position "Tanks open," i.e., both groups are switched on. With ignition of the red warning lamps there is critical fuel remainder, which corresponds to 110 l of fuel in both groups of tanks. During aviation-chemical operations flights are ceased for servicing the aircraft with fuel, and in transport flights an area is selected for the execution of a forced landing of the aircraft, since the presence of 110 l fuel provides engine operation for 20-30 min to its complete shutdown.

Three-way fuel cock or charging cock is included in the line between the four-way cock and sump filter and serves for refueling the aircraft from the BPK-4 electric pump on the ground, with this the access of fuel to the engine is covered.

In its construction the three-way cock is similar to the four-way cock with the exception that its cover is solid, without a drain plug.

In the cock housing there are three branches with openings, which are connected with the fuel feed and BPK-4 pump lines.

The handle of the three-way cock has two positions: "Feed" and "Servicing." The holding of the slide valve is analogous to the holding of the four-way cock.

The cock is controlled only on the ground by switching the handles installed on the cock. Access to the cock is provided through a bottom hatch in the forward section of the fuselage. After placing the cock in the "Feed" position the cock handle should be locked.

Fuel sump filter (Fig. 105) is installed in the fuel system line and serves for cleaning the fuel from mechanical impurities and water residue. The sump filter is fastened to the bracket of the set of fuel units (BPK-4, three-way cock, filter).

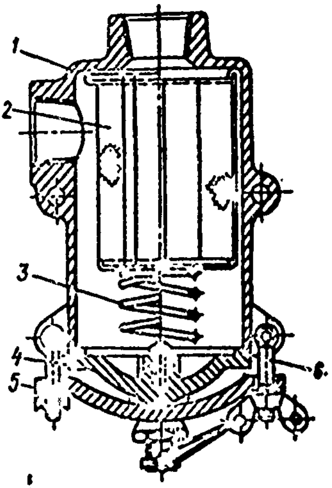


Fig. 105. Fuel sump filter: 1 - housing; 2 - filter screen; 3 - spring; 4 - cover; 5 - crosspiece; 6 - eye bolt.

The filter consists of a cylindrical housing and cover, cast from AL4 aluminum alloy, filtering element with spring and two fittings.

The feed line with 18 × 16 mm cross section is connected on the side of the filter housing through an angle plate with taper thread.

Into the upper part of the filter there is screwed a crosspiece on taper thread, to which are connected three branch lines to the BNK-12BK fuel pump with cross section 18 × 16 mm, to RNA-1A hand pump (alveyer) with cross section 15 × 13 mm and to priming pump (injector) with cross section 6 × 4 mm.

The screen of the filtering element together with the spring is bolted to the cover and is held in the housing by a crosspiece with a wing screw.

The filter is bolted to the bracket of the set of units with two bolts.

On the latest issues of aircraft there is installed a secondary fuel filter with paper filter element.

Hand pump RNA-1A (alveyer) serves for creation of pressure in the fuel system before engine starting, check of the connections of the system for airtightness, furthermore in the case of failure of the fuel pump BNK-12BK in flight by the hand pump it is possible to create fuel pressure in the system for the provision of normal engine operation.

Hand pump (Fig. 106) consists of a housing with cover, moving impeller with openings for transfer of fuel from cavity to cavity, two suction and two delivery valves, installed in stationary boxes, and a drive, mounted on the splines of the impeller shaft.

The housing with cover are made from gray cast iron. The cover is bolted to the housing on six bolts. The airtightness of the joint of the cover and housing is ensured by rubber packing, placed in the annular groove of the cover. In the housing on threads there are screwed two fittings: A - for fuel feed and B - for removal of fuel.

In the cavity of the pump housing there are installed valves made of aluminum alloy and a steel impeller.

The suction and delivery valves consist of valve boxes and plates, which freely rotate on shafts. The valve boxes are rigidly installed in the cavity of the pump housing and are fixed by two pins each.

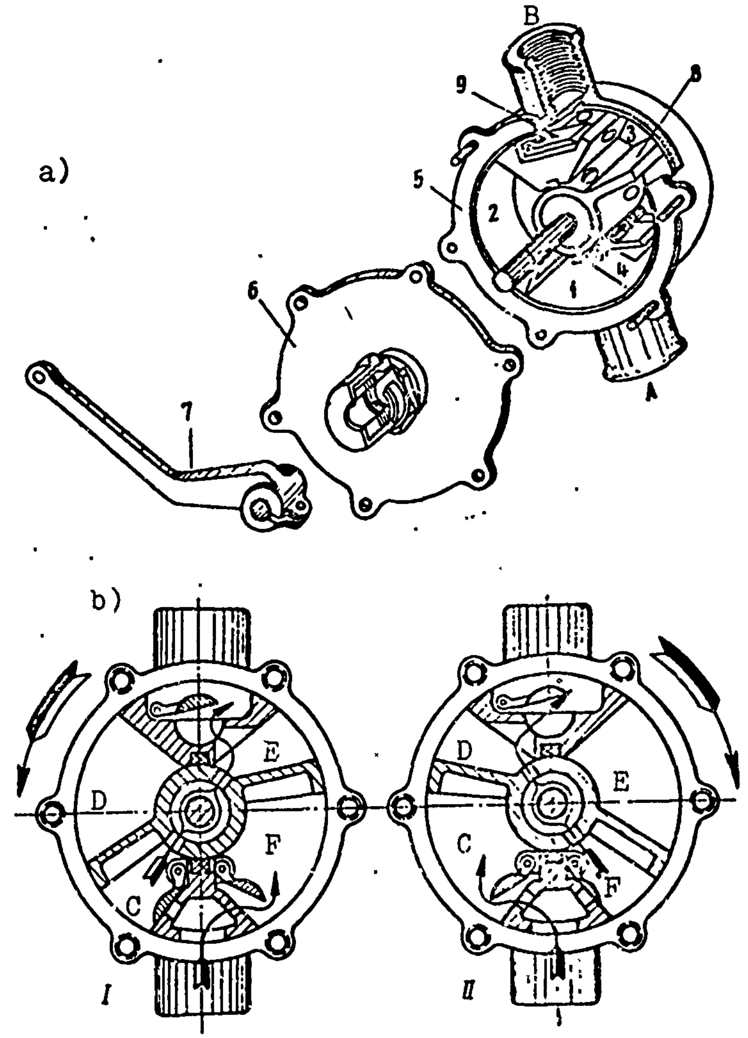


Fig. 106. Hand fuel pump: a) pump device: 1, 2, 3, 4, - pump cavities; 5 - pump housing; 6 - cover; 7 - drive; 8 - impeller; 9 - delivery valve; A - entry of fuel; B - exit of fuel; b) diagram of operation of hand pump.

For airtightness into the grooves of the seats of suction and delivery valves there are placed leather gaskets. The effective surfaces of the impeller and inner surface of the housing are rubbed. The impeller in the cylindrical part has two annular channels, not joined together, serving for the transfer of fuel during operation of the pump.

Hand pump operation. During rotation of the impeller counterclockwise (see Fig. 106b, position 1) the volume of cavities is changed and the impeller blades displace fuel located in cavities C and E through the delivery valves into the line. From cavity C fuel through the central annular channel of the impeller is forced into the line through cavity E. During this time in cavities D and F, the volumes of which are increased, fuel is sucked in from tanks through the suction valves, whereupon fuel proceeds from cavity F into cavity D through the second central annular channel.

During rotation of the impeller clockwise (see Fig. 106b, position II) fuel is sucked into cavities C and E, and from cavities D and F fuel is forced into the line. This is repeated until movement of the pump handle is ceased.

The hand pump is installed below on the left vertical wall in the passageway of the flight deck on the right side of the left pilot's seat.

Fuel system lines. The main fuel system line is made of AMgM alloy tubes 18 × 16 mm in diameter and flexible hoses of All-Union Scientific Research Institute of Aviation Materials [VIAM] (ВИАМ). The connection of tubes is rigid, with the exception of the power plant section, where hose connections are used. The entire line is painted with A6 yellow enamel.

Fuel from the tanks proceeds along low pressure hoses and tubes through check valves and enters the four-way cock.

Pendulum type check valves in the connections of fuel tanks exclude the possibility of overflow of fuel from the root and central tanks into cantilever tanks during aircraft flights with turns and slipping.

Check valves (see Fig. 100), installed in the servicing system line from the BPK-4 pump, direct fuel to the central and cantilever tanks and by this provide uniform fueling of tanks and protect the root tanks from swelling.

In the power plant section as well as in the junctions of the wings with the fuselage the main fuel system line is made with flexible hoses.

The drain of all the tanks is united into a common line and has common exit into the atmosphere under the left fillet of the upper wing. The deficiency of the drain system on the first series of aircraft consists of the fact that with the full fueling of the aircraft or during aircraft flights with banks and turns the fuel filled the drain lines and with aircraft level out was poured out.

On aircraft from the 53rd series there is made a lead of the drain to the radio mast (Fig. 107), due to which the operation of the drain system was improved and pouring out of fuel during aircraft maneuvers in flight was eliminated.

When testing the operation of the drain system, leading to the radio mast, it is necessary to:

1) disconnect line 3 from tee 4 and blow compressed air through in direction from the tee (for the removal of contamination from the line);

2) stop up the two drain holes in radio mast 1;

3) open the cover of filler neck 2 on the right cantilever tank;

4) feed air (with cock 5 closed) through tee 4 under pressure

up to 0.5 kgf/cm^2 and by listening check that the air is proceeding into the right group of tanks;

5) disconnect the air;

6) close filler neck 2 on the right group of tanks;

7) similarly repeat the test for the left group of tanks;

8) connect line 3 to tee 4.

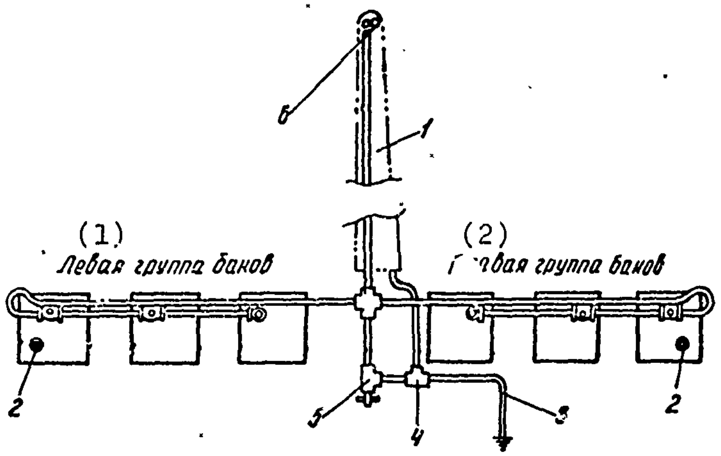


Fig. 107. The fuel tank drain system installed on aircraft from the 53rd series: 1 - radio mast; 2 - filler neck; 3 - line; 4 - tee; 5 - fuel drain cock; 6 - two drain holes in the radio mast.

KEY: (1) Left group of tanks; (2) Right group of tanks.

During operation there were observed formations of icy plugs in the fuel system of the aircraft. This defect is removed by eliminating the sags, which contribute to the accumulation of moisture when the aircraft is parked in the three-point position.

On aircraft from the 70 series the installation (bending) of fuel lines between frames Nos. 6 and 7 has been improved, preventing accumulation of residue of moisture when the aircraft is parked.

Engine priming system. The engine priming system includes the priming pump (injector) and the lines which connect it with the engine supercharger, carburetor and BNK-12BK pump. The lines, which feed fuel to the priming pump for filling the cylinders of the carburetor and BNK-12BK pump, are made from AMgM alloy tubes with cross section 6 × 4 mm. The priming pump (Fig. 108) serves for filling the engine with fuel before starting, and also for filling the BNK-12BS pump through the carburetor with hand pump RNA-1A inoperative.

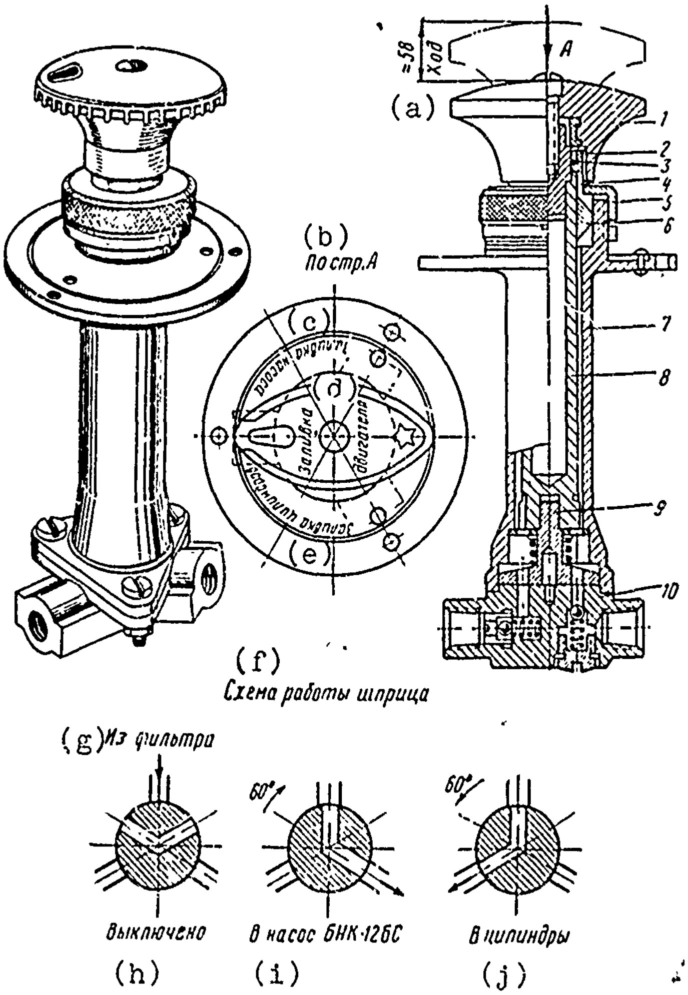
The priming pump is mounted in the cockpit on left side panel in its rear part. It is the housing, into which the piston with handle and slide valve is installed. The head with check valves and three fittings is bolted to the housing with three bolts. To the two fittings are connected the tubes which feed the fuel to the supercharger for filling the engine cylinders as well as to the carburetor for filling the BNK-12BK, and to the third (equipped with ball valve) - the tube which brings fuel from the sump filter to the priming pump.

Into the housing of the fitting there is inserted a switching cock with a valve, which prevents the suction of fuel during engine operation. The switching cock provides engine priming and if necessary provides priming of the BNK-12BK pump.

It is possible to operate the pump only in two positions of the handle "Filling of cylinders" or "Filling of pump." In the other positions the piston cannot have forward motion. Both working positions of the piston are fixed with the aid of a special protrusion on the piston, entering one of the two grooves, which are located in the housing.

During the motion of the pump plunger upward there is created rarefaction in the cylinder, and fuel from the system goes along the channel into the cylinder of the pump. During plunger motion downward the piston supplies fuel through the cock to either line depending on the position of the cock, set by the pump handle.

The filling of BNK-12BK pump on the ground by the priming pump is performed only in the case of failure of the RNA-1A hand pump.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60°
60°
Выключено
В насос БНК-12БС
В цилиндры
(h)
(i)
(j)

Fig. 108. The priming pump of the engine (injector): 1 - handle; 2 - sleeve; 3 - spring; 4 - support sleeve; 5 - nut; 6 - packing (stuffing box); 7 - pump housing; 8 - piston (plunger); 9 - slide valve; 10 - head with check valves.

KEY: (a) Stroke; (b) Along pointer A; (c) Priming of pump; (d) Engine priming; (e) Priming of cylinders; (f) Diagram of operation of pump; (g) From the filter; (h) Shut off; (i) To BNK-12BS pump; (j) To cylinders.

Perform priming of engine cylinders before starting only with the priming pump.

It is forbidden to rotate the engine propeller before starting when the cylinder head temperature is above 80°C.

It is forbidden to perform engine priming with the acceleration pump (throttle control) to avoid the ignition of fuel at the exhaust and ignition of the covering of the lower wing of the aircraft.

§ 28. OIL SYSTEM

The oil system consists of oil tank, MSh-8 oil pump, air-oil cooler (item No. 1106), drain cocks and lines.

The assembly diagram of the oil system on aircraft to the 30th series is shown in Fig. 109a. Figure 109b shows the assembly diagram of the oil system on aircraft from the 13th machine of the 36 series.

The difference of oil systems is the fact that on aircraft from the 12th machine of the 34th series with ASh-62IR engine of the 12th series, and, starting with the 13th machine of the 36th series and on subsequent series, there is installed a lightened oil tank of improved construction. Inside the tank is inserted a tube for drainage of the tank with the atmosphere, the oil dilution line with fuel is connected to the scavenging oil line between the cooler and tank and improved oil drain cock from the tank.

The schematic diagram of the oil system is shown in Fig. 110.

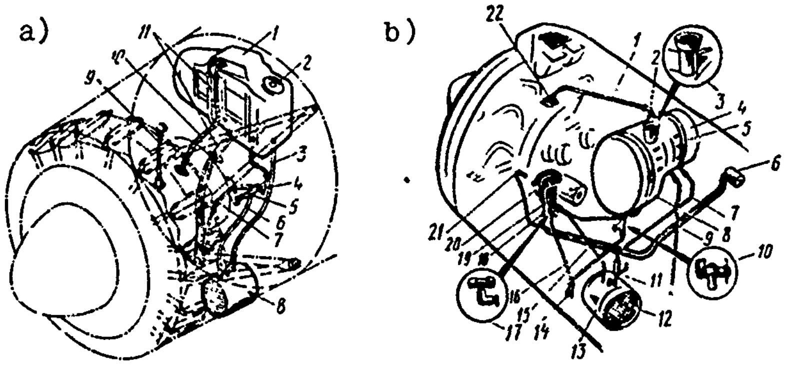


Fig. 109. Assembly diagrams of the oil system:
a) on aircraft up to the 36 series: 1 - oil tank; 2 - filler neck with oil level gauge; 3 - oil cooler outlet line; 4 - oil drain cock; 5 - oil inlet line to engine; 6 - oil outlet line from engine; 7 - oil drain line; 8 - air-oil cooler; 9 - engine breather; 10 - engine drain line; 11 - oil tank vent pipe;
b) on aircraft from the 36th series: 1 - engine drain with tank; 2 - angular fitting; 3 - filler neck; 4 - oil tank; 5, 8 - attachment band of tank; 6 - EMI-3K three-pointer indicator; 7 - oil branch line into the tank Ø 27 × 25; 9 - oil tank drain; 10 - drain cock; 11 - fitting for connection of oil dilution line; 12 - cells; 13 - oil cooler; 14 - oil drain tube from oil tank; 15 - oil branch line into cooler; 16 - drain tube; 17 - drain cock; 18 - electric wire; 19 - thermometer transmitter; 20 - MSh-8 oil pump; 21 - manometer sensor; 22 - breather fitting, installed on the front supercharger housing.

Oil tank. On aircraft up to the 36th series of the 12th machine there was installed an oil tank with capacity 120 *l*. The tank - of welded and riveted construction, is made from plates of AMtsA alloy 1 mm thick, except the bottom, the material of which is 1.2 mm thick.

The frame of the tank consists of three vertical partitions, one horizontal partition and four longitudinal sections, which support the shell. The partitions have flanged holes for lightening.

In the tank is located an antifoam well, which also serves for rapid warming up of oil in the tank after engine starting. The well has cylindrical shape and is welded to the horizontal partition of the tank.

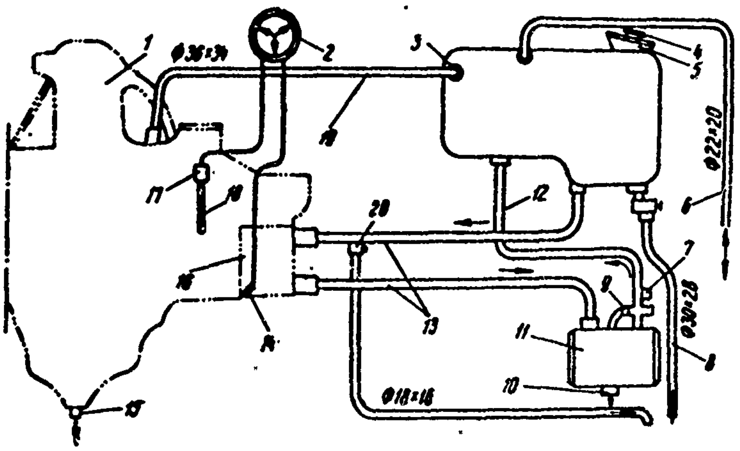


Fig. 110. Schematic diagram of the oil system on aircraft from the 36th series: 1 - ASh-62IR engine; 2 - three-pointer EMI-3K electric indicator; 3 - oil tank; 4 - oil gauge; 5 - filler neck; 6 - oil tank drain; 7 - fitting for connection of the oil dilution line; 8 - oil drain tube from the oil tank; 9 - reducing valve; 10 - oil drain from cooler; 11 - oil cooler; 12 - oil branch line into the tank Ø 27 × 27; 13 - line; 14 - thermometer transmitter; 15 - oil drain from engine; 16 - MSh-8 oil pump; 17 - manometer sensor; 18 - capillary of the manometer sensor; 19 - engine drain with tank; 20 - oil drain cock from the engine feed line.

The stamped shells and bottom from AMtsAM alloy are riveted to the frame. The attachment rivets are rounded outside.

Convex bottoms, transverse partitions, longitudinal stiffening sections, which support the shell, and also grooves on the shell impart rigidity to the construction of the tank.

The tank is welded by torch welding, after which it is tested for airtightness under pressure 0.35 kgf/cm^2 and for vibration for 30 min with frequency 1500 vibrations per minute at amplitude 0.17 mm. After testing the tank is painted with A8 brown enamel.

On aircraft from No. 136-13 there is installed an oil tank of more lightened and simpler construction (Fig. 111) with capacity 125 *l*. The tank has a shell stamped from two halves of plates of AMtsA alloy and riveted to three partitions (each partition consists of two halves). Both halves of the shell are welded after riveting of the partitions together. Inside the tank is inserted the antifoam well, the tube, carrying oil from the cooler, and the drain tube of the tank of connection with the atmosphere. The antifoam well on top is welded to the partition, and at the bottom is welded to the shell of the tank and has an opening for oil outlet from the well.

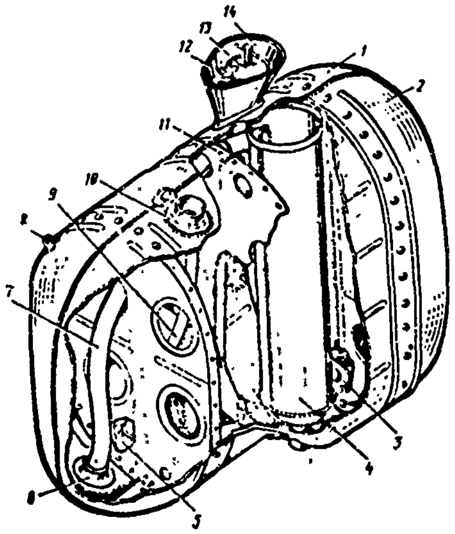


Fig. 111. Oil tank of lightened construction, installed on aircraft from the 36th series: 1, 2 - shells; 3 - fitting drain; 4 - preheating and antifoam well; 5 - drainage fitting; 6 - oil return fitting to the tank; 7 - drainage tube; 8 - metallization eye; 9 - oil return tube to antifoam well; 10 - engine draining fitting with tank; 11 - partition; 12 - oil level gauge; 13 - cover with filler neck; 14 - filler neck with filter.

The bottom part of the tank has four fittings: fitting for connection of the oil feed tube, fitting for overflow and drainage tubes and fitting for connection of the oil feed tube from the cooler to the tank (to antifoam well).

The upper part of the tank has a filler neck with gauge and fitting for connection of the engine drain hose through the tank. Outside the tank has two eyes welded on for the attachment of two metallization crosspieces.

The oil tank is installed on seats, fastened to frame No. 1. The tank is fastened to them with two duralumin bands with clamps. On the seats for the best shock absorption of the tank there are installed felt gaskets, and under the bands - rubber gaskets.

During operation there were observed cracks of oil tanks basically at welds, around rivets and fittings.

For preventing the appearance of cracks in the shell of the oil tank, and also the shear of rivets in the lower attachment zone of the middle partition to the shell the oil tank is made of AMtsAML1, 2 instead of AMtsAML1, in the lower zone of the tank there is introduced a reinforcing knee and six rivets are additionally installed.

On aircraft from the 141st series there is removed the reinforcing of the oil tank dilution hose at the point of passage of the hose through the inner cowling and from the 163 series the diameter of the flange of the drain fitting is increased.

Air-oil cooler. On aircraft there is installed a fine-cell oil cooler - item No. 1106 (Fig. 112), made from K-4 tubes 250 mm long with wall thickness 0.2 mm

The radiator box is made from brass sheets, the tubes are made from industrial copper.

The cooler consists of two shells, external and inner, six inclined partitions with windows for oil circulation, fitting for the inlet of oil to the radiator and fitting for oil outlet with the branch pipe, in which the spring reducing valve has been placed. For oil drain from the cooler there is a fitting with plug.

The inner shell is riveted to the inclined partitions, and to the cells - soldered. The tubes are divided by inclined partitions into seven sections.

The inner shell in the upper part has a window for the inlet of oil to cells of the cooler and in the bottom part - window for oil outlet from the cells.

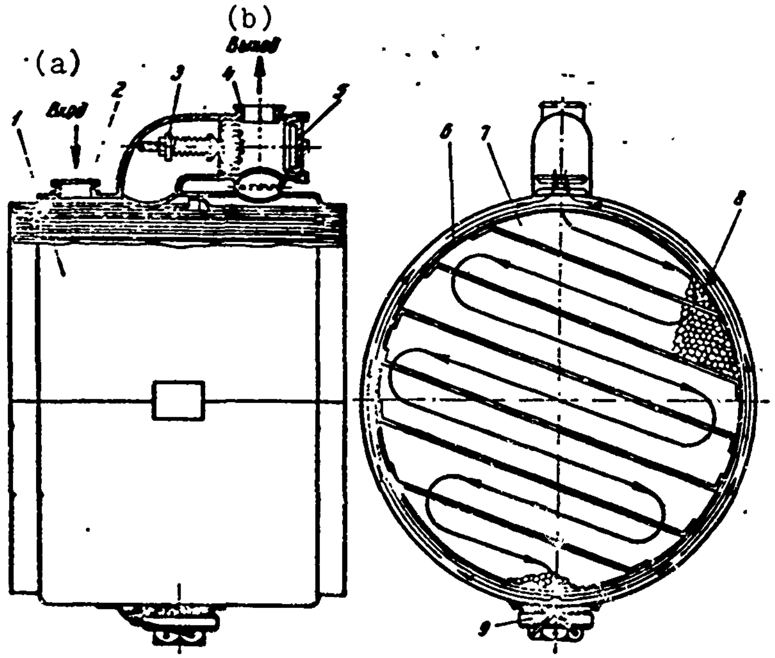


Fig. 112. Air-oil cooler: 1 - external shell; 2 - intake pipe; 3 - reducing valve; 4 - exhaust duct; 5 - plug; 6 - inner shell; 7 - partitions directing the oil; 8 - cells; 9 - drain plug.

KEY: (a) Inlet; (b) Outlet.

The oil between the tubes of the cooling sections and through the openings of partitions circulates in a zigzag manner from top to bottom.

The external shell is soldered to the inner so that between them an annular slot is formed, through which oil heads toward the outlet. To the external sheel in the upper part are riveted and soldered the branch pipe of the reducing valve, inlet and outlet pipes. The exhaust duct is connected with the branch pipe of the reducing valve.

The intake pipe and the branch pipe of the reducing valve are separated from the annular space between shells and the outlet fitting by a special partition.

In the bottom part of the external shell there is located the drainage fitting, which is closed with a plug.

Basic performance data of oil cooler

Type of cooler........................	fine-cell round No. 1106
Diameter of cooler, mm...............	290
Front surface, dm^2..................	6.3
Cooling surface, m^2..................	7.7
Size and type of tubes, mm...........	250 × 0.2 type K-4
Number of tubes in the cooler, pieces............................	2650
Dry weight of cooler, kg.............	27.5
Capacity of cooler, *l*.................	8.5
Operating pressure, kgf/cm^2..........	4
Bursting pressure, kgf/cm^2...........	16
Valve calibration, kgf/cm^2...........	4
Pressure during air test, kgf/cm^2....	5
Pressure during water pressure test, kgf/cm^2.....................	8

For protection of the oil cooler from overload in the case of oil pressure increase with increase in its viscosity under low-temperature conditions a reducing valve has been installed, which is calibrated to pressure 4 kgf/cm^2 and works in the following manner.

During engine starting, when cold oil exists in the system with increased viscosity, the flow friction between the tubes of the cooler will be very great and the oil pressure in cells will be above 4 kfg/cm^2, which will cause the opening of the reducing valve. With this the oil, passing the cells, will proceed along the cavity between the inner and external shells, past the reducing valve and flow into the tank. Gradually the oil under pressure 4 kgf/cm^2 is forced from the cells, pressure in the cells of the cooler will be reduced and the valve will be shut. Subsequently oil will circulate through the cells and the slotted space between the shells and enter the tank.

The oil cooler is installed in the bottom part of the aircraft and is fastened to the joints, located on frame No. 1, and to the framework of the inner engine cowling with the aid of steel bands, secured by bolts. Between the bands and the shell of the cooler rubber gaskets are installed. Outside the cooler is enclosed by an easily removable duct and by a casing with shutters. Air enters the cells of the cooler through the duct. The intake of air is regulated by flaps controlled from the cockpit.

During operation there occurred cases of the leakage of oil from the cells of the oil cooler. This deficiency in most cases is manifested during the winter period as a result of the incompetent operation of the oil system. For preventing such cases it is necessary for flying and technical personnel to repeatedly study the manual for summer and winter operation of the An-2 aircraft during the transition from the summer period of operation of the aircraft to the winter in the required order.

When flushing the cooler it is necessary to check it for airtightness under pressure 6 kgf/cm^2.

The guaranteed service life of the cooler is 900 h. The shelf life of the cooler is 2 years.

Lines and drain cocks of the oil system. The connection of lines with the units of the oil system is accomplished by flexible and rubberized hoses, with the exception of tubes for connection of the oil tank with the atmosphere, which is joined to the tank with the aid of a union nut.

The feed line from the oil tank to the engine oil pump consists of a 27 × 25 mm tube, made of 20A steel, and low-pressure hose Specification [TU] (TY) No. 1707-50R.

The 27 × 25 mm tube from the oil pump to the air-oil cooler is made of D16T duralumin. The drainage line of the tank with the engine - flexible. All the remaining lines are made of AMgM alloy.

The tube connecting the tank with the atmosphere is made with 22 × 20 mm cross section. The oil drain tube from the tank has 30 × 28 mm cross section. The oil drain tube from the oil feed line to the engine is made with 18 × 16 mm cross section.

Oil can be drained from the oil system of the aircraft from four points:

1) from the oil tank through the drain plug cock on aircraft up to the 36 series and through an improved spring cock on aircraft from the 36 series;

2) from the oil cooler through a standard drain plug with a nut under the wrench;

3) from the oil feed tube to the engine in winter through the plug cock;

4) from the sump of the engine through the oil plug cock.

The tube for oil dilution with fuel is connected to a fitting on the scavenge line, which goes from the oil cooler to the tank.

On aircraft from the 36 series it is permitted to perform oil dilution with fuel.

The temperature measurement head of the incoming oil to the engine is installed in the fitting of MSh-8 oil pump.

The sensor of the oil pressure gauge on aircraft up to the 69 series was installed on the lower brace strut of the engine mount on the left side and was connected with the oil pump fitting with the aid of an armored hose.

On aircraft, beginning with the 1st machine of the 70 series, the sensor of the oil pressure gauge is installed on the right upper brace strut of the engine mount and is connected with the aid of an armored hose with the upper fitting of the engine crankcase rear cover. The oil pressure gauge with the new location of the sensor indicates pressure in the line 4-5 kgf/cm^2.

The schematic diagram (see Fig. 110) shows the oil circulation in the system. Oil from the tank enters the engine pump, then the air-oil cooler. After cooling in the oil cooler the oil through the line enters the tank, and, flowing along the wall of the antifoam well, it again enters the engine.

Servicing the tank with oil, as a rule, should be performed from a Water and Oil Servicing Truck [VMZ] (BM3). If there is no VMZ it is permitted to service from clean cans, which should be sealed at delivery to the airfield. It is permitted to pour oil into the tank from cans only through a funnel with a fine screen.

It is forbidden to fill the oil tank with open buckets.

In cold weather from +5°C and below pour oil into the tank heated to 75-85°C, and before engine starting itself drain off the oil sediment (0.8-1 l) through drain cocks from the tank and the oil feed line to MSh-8 pump.

It is forbidden to pour oil, made foamy during preheating, into the tank.

For the first engine test on the ground and for test flight of the aircraft after engine replacement it is necessary to pour

55-50 *l* of oil into the tank.

The oil-dilution system. On aircraft from the 172 series in the oil-dilution system there are introduced modifications of the system and the appropriate change in the instructions and the dilution chart as compared with the earlier approved.

In the oil-dilution system at the outlet from the EKR-3 magnetic valve instead of fitting 6A All-Union State Standard [GOST] (ГОСТ) 552-41 there is installed fitting (jet) Sh6100-377 with flow passage area 2.1A in diameter. The fitting ensures constant output of the magnetic valve and, consequently, steady entry of fuel into the oil within limits of TU ($12.5^{+0.5}_{-0.2}$%) under the condition of performance of dilution according to the new instructions and to the new airborne chart.

From aircraft of the 60 series, i.e., from the moment of installation of EKR-3 magnetic valves, the installation of new fittings (jets) and the replacement of the airborne chart are produced by personnel of the operational concerns. Fittings (jets) Sh6100-377 and airborne charts Sh6100-378 are supplied by the supplying organization according to the requirement of the operational concerns.

§ 29. ENGINE STARTING SYSTEM

The aircraft are provided with two engine starting systems: from electrical inertia starter RIM-24IR and manual starting by means of spinup of the starter flywheel by a hand drive.

The main engine starting system is starting from the RIM-24IR electrical inertia starter, the complete complex of which includes:

1) electromagnetic relay VM-177, mounted on the electric starter;

2) dog relay RA-176M, installed next to relay VM-177;

3) starting button KS-3, installed on the main instrument panel.

The starting ignition voltage on the engine spark plugs is supplied from KP-4716 booster coil, installed on the right upper engine mount strut.

Electric starting of the engine is accomplished from the cockpit with the aid of units mounted on the main instrument panel on the left side above, which include:

1) AZS-20 starting circuit;
2) PM-1 magneto switch;
3) KS-3 starting button.

Electric starting of the engine should be performed, as a rule, from a ground power source, and in its absence - from the aircraft battery. The accumulator voltage during engine starting should be not less than 24 V with load 6 A. As the load, before checking the accumulator voltage, the RV-2 and RSI are turned on.

In the case of absence of a ground electric power source and insufficient charging state of the aircraft battery, which can occur during operation of the aircraft under off the airfield conditions, it is permitted, as an exception, to start the engine by using the hand drive of the electric starter.

The device for manual starting consists of a handle, intermediate shaft with ratchet, universal joints of connecting shaft, reduction gear, yoke and bearings.

For convenience of starting the ratchet of the hand drive leads into the cargo compartment and is located on frame No. 5 on the right side, if we look in the direction of flight. In the nonworking position the starting handle is installed on frame No. 5 in a special seat.

The intermediate shaft with ratchet and universal joint is installed on bearings mounted on fuselage frames No. 1 and 5.

The intermediate shaft is connected to the reduction gear by the universal joint and connecting shaft. The reduction gear is installed on a welded bracket, located on an engine mount brace strut.

The intermediate link between the reduction gear and starter flywheel is a yoke, connected by one end through a universal joint with the reduction gear, and the other end - with shank RIM-24IR.

The manual starting reduction gear consists of a cast housing made of AL9 alloy, bevel gears made of 30KhGSA steel, and two bearings, pressed into housings, made from D16T duralumin.

The intermediate shaft with ratchet, universal joint, connecting shaft and yoke are made of 30KhGSA steel.

The rotary motion of the starting handle through the intermediate and connecting shafts is transferred to the reduction gear, which through the yoke transfers rotation to the starter flywheel at a 90° angle.

During engine starting it is necessary to turn the handle clockwise, first slowly, and then to gradually and smoothly bring the spin rate to 70-80 rpm, with this the starter flywheel will have revolutions about 14,000 per minute and a fine uniform roar. Switch on the ignition and the safety switch of the AZS-20 starter "Start," and push the handle of the start button with the inscription "Starter" "Forward" and start the engine.

Frequent use of manual starting is not recommended in order to avoid wear of the bevel gears of the reduction gear and other components of manual starting.

§ 30. ENGINE, COWL FLAP AND OIL COOLER FLAP CONTROL

Engine Control

Engine control is accomplished with the aid of levers and quadrants, installed on the central control panel in the cockpit.

On the control panel (Fig. 113) are located the control levers and quadrants for:

1) altitude mixture control;
2) engine throttle;
3) propeller pitch;
4) carburetor heating;
5) engine shut-off (stop-cock);
6) dust filter.

The engine control levers and quadrants are made from Chromansil sheet steel. On the ends of the levers are attached standard plastic knobs with lettering and appropriate coloring. The location of levers is accessible for their use both pilot and copilot seats.

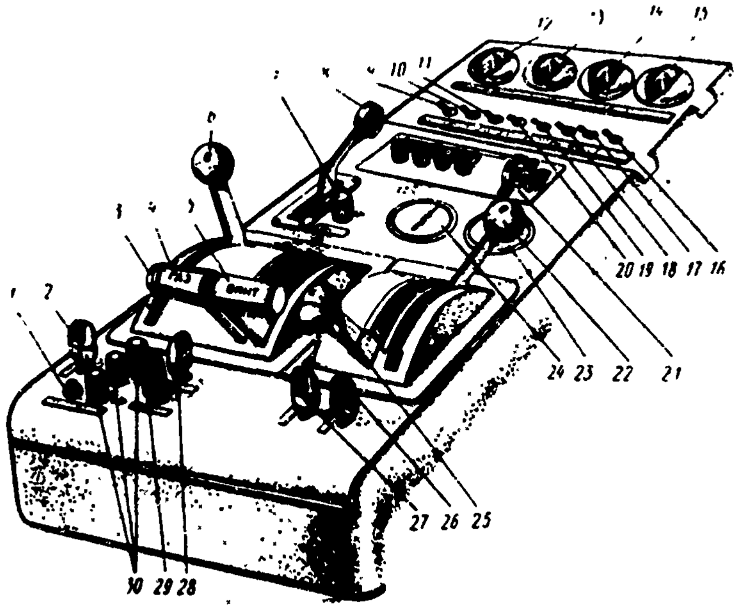


Fig. 113. Levers of central engine control panel: 1 - flap retraction button; 2 - elevator trim tab pressure switch; 3 - flap lowering button; 4 - throttle lever; 5 - propeller pitch lever; 6 - altitude mixture control lever; 7 - door warning light; 8 - dust filter lever; 9 - generator switch; 10 - battery switch; 11 - circuit breaker of DIK-46 compass; 12 - rheostat of left light of ultraviolet illumination [UFO] (УФО); 13 - rheostat of UFO light on :. rod; 14 - rheostat of UFO light on rod; 15 - rheostat of right light of UFO; 16 - circuit breaker of TUE-48 thermometers; 17 - circuit breaker of flap position indicators and oil cooler; 18 - EMI-3K circuit breaker; 19 - fuel gauge circuit breaker; 20 - gyrohorizon circuit breaker; 21 - R-800 radio panel; 22 - engine shut-off lever; 23 - oil cooler flap position indicator; 24 - flap position indicator; 25 - carburetor heating lever; 26 - cowl flap pressure switch; 27 - oil cooler flap pressure switch; 28 - rudder trim tab pressure switch; 29 - aileron trim tab pressure switch; 30 - trim tab neutral position signal light.

On the panel near each lever there are installed plates with inscriptions and pointers indicating the direction of their travel. All the inscriptions on plates and letterings on the lever knobs are coated with a substance to provide limited-duration luminescence.

The engine control levers are assembled in two duralumin brackets on a common axle. The control levers of altitude mixture control, throttle and propeller pitch are stopped by a common stop, located on the left side of the panel. By rotating the stop nut on the threaded end of the shaft there is provided the necessary amount of tightening of levers in the overall complex.

The carburetor heating lever has individual locking with the aid of a pawl installed on the quadrant.

The engine shut-off and dust filter levers can have only two positions: "On" and "Off."

The engine control linkage (Fig. 114) consists of rigid adjustable rods with intermediate actuating arms and cables with rollers.

Control of altitude mixture control, throttle and carburetor heating is accomplished with the aid of rigid rods.

Propeller pitch, engine shut-off and dust filter are controlled by a cable run.

All the intermediate actuating arms are installed on ball bearings, which provide ease of control. Intermediate actuating arms are connected to rods by bolts and castle nuts.

On aircraft from the 56 series (Fig. 115) for improvement in the construction on the actuating arms of the engine control instead of spherical bearings, bronze and steel bushings there are installed ShS6 self-aligning bearings. Closed-type ball bearings 980077 are installed under the axles of actuating arms.

If it is necessary to replace control parts on aircraft up to the 56 series the aircraft manufacturer recommends replacement by set. In the case of the complete replacement of the engine control it is necessary to perform modification of the throttle, altitude mixture control and carburetor heating quadrants according to the manufacturer's bulletin.

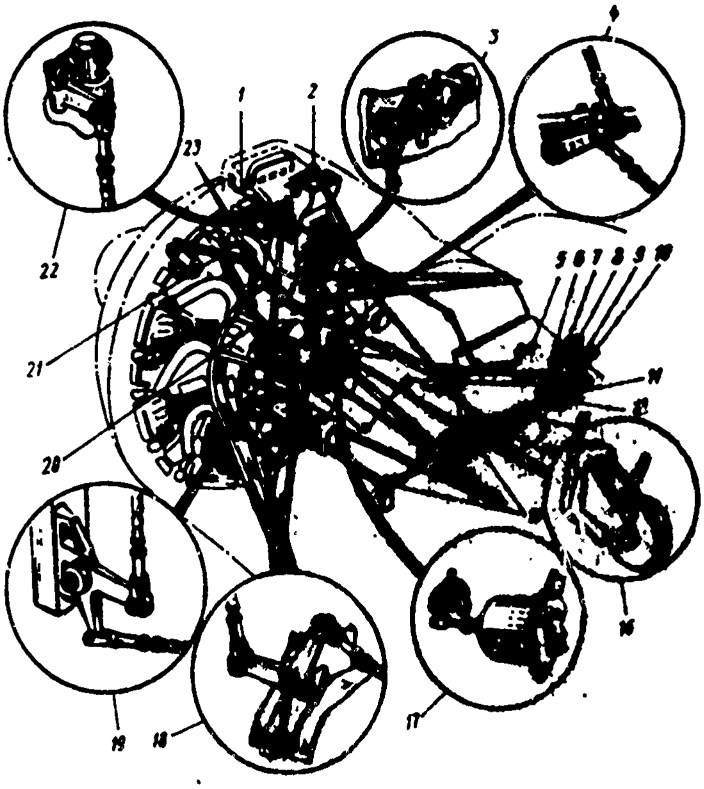


Fig. 114. Assembly diagram of the engine control and its units: 1 - holder control guide; 2 - preheating flap axle guide; 3 - gear quadrant of the throttle drive; 4 - intermediate lever with preheating control rods; 5 - the control lever of antidust filter holder; 6 - control lever of altitude mixture control; 7 - engine throttle lever; 8 - propeller pitch control lever; 9 - control lever for preheating the air entering the carburetor; 10 - engine shut-off control lever; 11, 12, 13 - rods; 14 - engagement handle of starter dog; 15 - intermediate actuating arms; 16 bracket with roller; 17 - ratchet relay RA-176; 18 - intermediate lever; 19 - intermediate lever; 20 bracket with roller; 21 - rigid rod; 22 - altitude mixture control; 23 - flexible shells.

Control of the alitude mixture control. For provision of normal mixture with change of the flight altitude on the carburetor of the engine there is installed an automatic altitude mixture control.

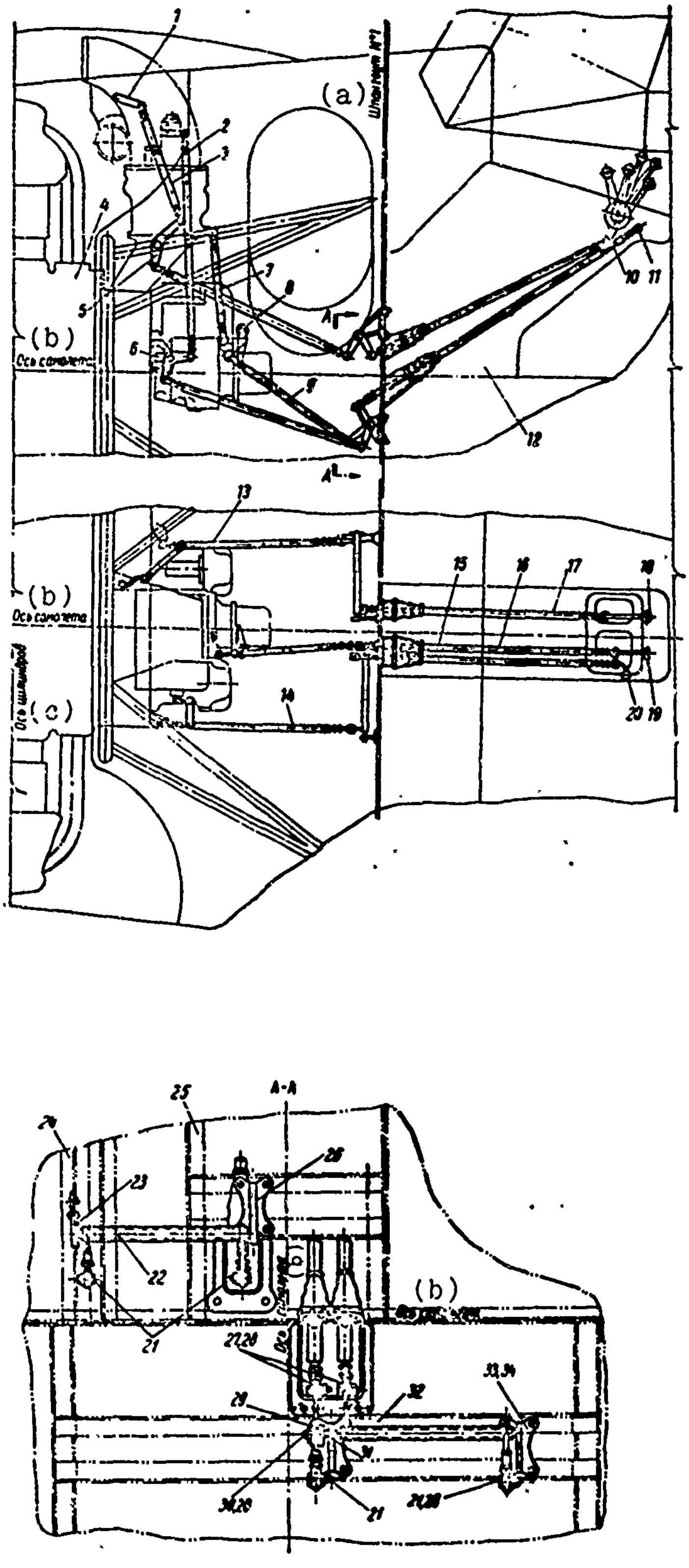


Fig. 115. Diagram of engine control on aircraft from the 56 series: 1 - guide (A6803-50); 2 - rod (Sh6500-191-4); 3 - rod (Sh6500-191-3); 4 - engine; 5 - actuating arm; 6 - bracket (Sh6500-194); 7 - rod (Sh6500-191-1); 8 - bracket (Sh6510-4); 9 - rod (Sh6500-191-2); 10 - washer (233A1-6-12); 11 - cotter pin (1.5 × 20 GOST 397-54); 12 - central panel; 13 - rod (Sh6500-192-2); 14 - rod (Sh6500-192-1); 15 - rod (Sh6500-190-1); 16 - rod (Sh6500-190-2); 17 - rod (Sh6500-190-3); 18 - carburetor heating quadrant; 19 - throttle quadrant; 20 - altitude mixture control quadrant; 21 - bolt (1888S6-20-17.5); 22 - actuating arm (Sh6500-87); 23 - bracket (Sh6200-170); 24 - groove of oil tank (information); 25 - frame No. 1; 26 - bracket (Sh6500-193); 27 - washer (233A26-12); 28 - cotter pin (1.5 × 20 GOST 397-54); 29 - actuating arm (Sh6500-196); 30 - nut (140606); 31 - washer (233A2.5-7-12); 32 - actuating arm (Sh6500-188); 33 - bracket (Sh6500-195-1); 34 - bracket (Sh6-195-2).

KEY: (a) Frame; (b) Aircraft axis; (c) Axis of cylinders.

The automatic altitude mixture control is duplicated by a manual control, which is used in the case of failure of the aneroid, and also for correction during imprecise operation of the automatic machine.

Manual control is carried out by rigid rods with two intermediate actuating arms. Intermediate actuating arms are installed in the load-bearing section: the first - on duralumin brackets and sections of frame No. 1, the second - on the welded bracket installed on the bolts of the engine crankcase rear cover.

The lever on the panel with the aid of duralumin rods through the levers of intermediate actuating arms is connected with the altitude mixture control guide, which is installed on the shank of the outlet roller of the automatic machine. The connection of the guide with the shank is splined.

The first intermediate actuating arm is of welded construction from a tube and levers made of Chromansil steel. The second intermediate actuating arm and the carburetor altitude mixture control guide are made from an AK6 stamping.

The extreme position of the altitude mixture control guide is fixed by the shank stops against lugs on the housing of the automatic machine and corresponds to the lever travel on the control panel.

On the panel in the cockpit the altitude mixture control lever is set in the extreme rear position for complete enrichment and is fixed in a slot of the panel. The front position corresponds to lean mixture.

The setting of the altitude mixture control guide of the carburetor during ground adjustment of the automatic machine is fixed by a general graduation mark, applied on the face of the roller and the clip of the lever.

Throttle control of the engine is accomplished analogically with control of the altitude mixture control.

On the extension of the shank of the actuating arm of the altitude mixture control, installed on frame No. 1, there is mounted the first intermediate actuating arm; the second intermediate actuating arm is installed on the axle of the welded bracket, fastened by bolts on the panel of RA-176 relay of the shank of RIM-24IR electric starter. The quadrant on the panel and the intermediate actuating arms are connected together and with the guide on the carburetor by duralumin rods.

On aircraft from the 151 series the throttle control from frame No. 1 to the bracket on RIM-24 is reinforced because of increase in the diameter of the tube and the diameter of the threaded part of the bracket. The guide is installed on the axle of the mechanism of the carburetor choke, the connection of the guide with the axle - splined.

The actuating arms are made from AK6 stamping, the guide on the carburetor from 30KhGSA steel stamping.

The throttle guide is fixed in the extreme positions by the stop installed on the carburetor housing. During motion of the guide downward as far as it will go ("Idling position) the adjustable bolt of the quadrant of the throttle mechanism will approach right up to the stop, and during motion upward ("Full throttle" position) - the rib of the quadrant of the mechanism.

The movement of the guide on the carburetor, limited by the stop, corresponds to the extreme positions of the lever on the panel. The extreme forward position corresponds to maximum takeoff power n = 2150-2200 rpm, $p_{\text{к}}$ – 1050 mm Hg (boosted condition), which corresponds to nominal engine power at critical altitude 1500 m. The extreme aft position of the lever corresponds to idling. The intermediate position of the quadrant in the slot of the panel (at the limiter) corresponds to nominal engine power on the ground (n – 2100 rpm, $p_{\text{к}}$ – 900 mm Hg).

Propeller pitch control is accomplished by a two-way cable run with two rollers. One of the rollers is attached to the lever of the control panel in the cockpit, and the second is installed directly on the roller of the speed governor R-7E.

The run consists of two cables 7 × 7 – 1.8 mm, connected by a clamp in the load-bearing section. The cable is preliminarily stretched before sealing off the end and installation on the aircraft. The cables are inserted into rollers with a loop and are bolted with a nut, locked by a cotter pin.

Cables from the propeller pitch control lever to the R-7E speed governor, at frame No. 1 and in the load-bearing section, on the inner cowling, pass through textolite rollers.

The extreme forward position of the propeller pitch control lever on the central panel corresponds to "Low pitch," extreme aft position - to "High pitch."

Full movement of the lever provides operation of the governor for equilibrium revolutions over the range 2200-1400 rpm.

With breakdown of cable control or failure of the oil system of the governor the propeller automatically provides cruising flight condition.

On the aircraft of the 111 series for the removal of the bending load from the roller of the R-7E speed governor the control cable run R-7E is replaced by rigid-cable run.

Before modification of control of the speed governor R-7E for easing the operating conditions of the roller of the speed governor it is necessary to make tension of cable runs within 4^{+2} kgf according to a tensometer.

The tension of cables in the system of a rigid-cable run should be 4^{+2} kgf according to a tensometer.

On aircraft from the 172 series the control rod of the R-7E speed governor is reinforced because of the lengthening of the sleeve and the introduction of an additional rivet.

Carburetor heating control is carried out by rigid rods with two intermediate actuating arms. The first intermediate actuating arm, installed on the bracket of frame No. 1, is welded and manufactured from Chromansil steel. The second intermediate actuating arm is made from AK6 stamping and is installed on the upper brace strut of the engine mount on a special bracket with a clamp made from 20A steel.

The intermediate actuating arms and the lever on the control panel are connected together, and also with the drive of the shutter by duralumin rods.

The extreme forward position of the lever provides full actuation of carburetor heating and corresponds to the inscription "Open." The extreme aft position of the lever turns off the carburetor heating and corresponds to the inscription "Closed." The extreme and intermediate positions of the lever are fixed by a rack on brackets and by a pawl, installed on the carburetor heating lever.

Engine shut-off control. For shutting off (stopping) the engine a carburetor stop-cock is used. Control of the stop-cock from a lever on the control panel to a lever on the carburetor is accomplished by one-way cable 7 × 7 - 1.8 mm. The cable is preliminarily stretched before installation on the aircraft. On the lever of the control panel the cable is sealed in the rollers by a ball; the roller is riveted on the quadrant. The other end of the cable is attached on the stop-cock lever by a standard ball lock, which provides the necessary adjustment of cable tension.

To avoid accidental activation of the stop-cock the control cable has some slack.

The extreme aft position of the lever on the control panel provides activation of the stop-cock on the carburetor. In this position the lever has a latch in the cutout on the panel.

In the extreme forward position of the lever on the panel the reverse movement of the rope is accomplished by the spring of the stop-cock.

At points of bending of cable there are installed guide rollers on the bracket bolted on the rear engine cover and frame No. 1.

Dust filter control in its construction is similar to the engine shut-off control. Dust filter control from a lever on the panel to a lever on the filter is accomplished by one-way cable 7 × 7 - 1.8 mm with a clamp.

The extreme aft position of the lever on the panel provides activation of the filter. In this position the lever has a latch in the cutout on the panel.

In the extreme forward position of the lever on the panel the reverse movement of the filter and cable is provided by a spring.

Cowl Flap Control

Control of cowling flaps is remote and is accomplished from the cockpit with the aid of UR-7 electrical mechanism, installed on frame No. 1. The UR-7 electrical mechanism is installed on frame No. 1 from the inside. The reduction gear of the UR-7 mechanism engages the gear quadrant, to which by means of two rods motion is transferred by the vertical actuating arms mounted in brackets with ball bearings on frame No. 1. The vertical actuating arms through brackets are connected by rods to the levers of the cowling duct flaps.

The UR-7 mechanism is actuated from the cockpit by NP-1 pressure switch, installed on the central panel behind the stop-cock lever and AZS-10 circuit breaker, installed on the central electrical panel.

With the battery and AZS-10 switched on with pressure on the NP-1 "Forward" the cowl flaps are opened and with pressure of NP-1 "back" the cowl flaps are closed. The position of the cowl flaps is monitored from the cockpit visually.

During operation after engine shutdown it is necessary to close the cowl flaps: in summer at cylinder head temperature not higher than 80°C and in winter not higher than 100°C to avoid overheating and melting of the rubber insulation of the conductors of engine ignition.

On aircraft from the 110 series for preventing sliding of the actuating arms from bearings of rigid engine control limiting washers are introduced.

Oil Cooler Flap Control

Oil cooler flap control, just as cowl flap control, is remote and is accomplished from a UR-7 electrical mechanism, installed on the housing of oil cooler flaps.

Pressure switch NP-1 is installed on the central panel next to the NP-1 of cowl flap control on the left side. The circuit breaker AZS-10 is installed on the central panel next to the AZS-10 of cowl flaps.

With pressure on the NP-1 "Forward" the flaps are opened and with pressure "Back" are closed.

For monitoring the state of the position of oil cooler flaps on the central panel next to the UZP-47 flap position indicator there is installed the UPZ-48 oil cooler flap position indicator. Both indicators are turned on by circuit breaker AZS-10, installed on the electrical panel of the central panel, the second to the right.

§ 31. FIRE-EXTINGUISHING EQUIPMENT

On the aircraft standard fire-extinguishing equipment has been installed, which consists of stationary fire-extinguishing equipment and a portable bottle.

The complete set of stationary fire-extinguishing equipment (Fig. 116) includes: bottle with capacity 2.5 *l* with fire-extinguisher head, two fire detectors, distributing collector with line and control of fire-extinguishing equipment.

The fire-extinguishing bottle with fire-extinguisher head (finished product) is filled with carbon dioxide CO_2 under pressure

150 kgf/cm^2. The weight of the empty bottle is about 4 kg, weight of CO_2 2-2.2 kg, the weight of the bottle with CO_2 about 6 kg. Weight of CO_2 and weight of bottle with CO_2 are painted in black on the bottle. The presence of CO_2 in the bottle is checked monthly by weighing.

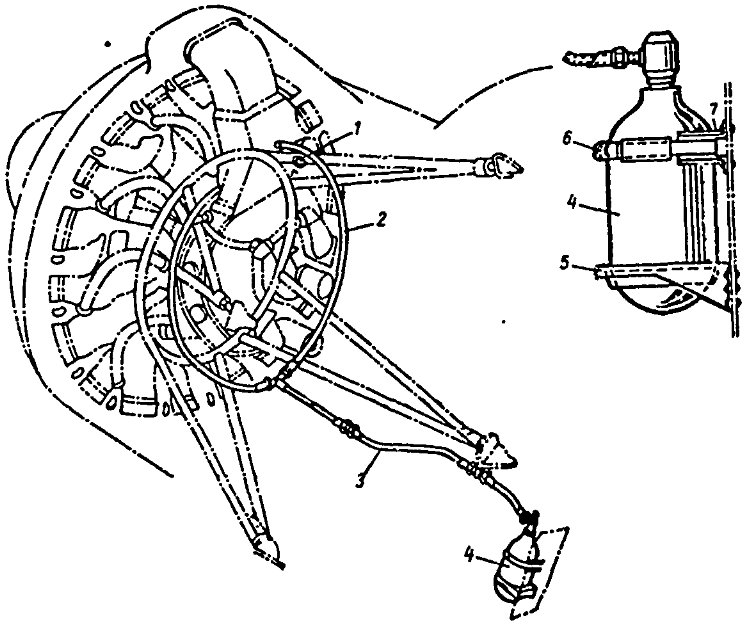


Fig. 116. Diagram of fire-extinguishing equipment: 1 - fire detector; 2 - distributing collector; 3 - line; 4 - bottle: 5 - saddle; 6 - band; 7 - bracket.

The bottle is fastened to frame No. 4 in a special saddle and bracket with a band. The bracket and saddle are made from D16 sheet duralumin.

The fire detector consists of a thermobimetallic membrane with contact screw and two forks, installed through the insulating parts in the metal housing.

The action of the instrument is based on the property of the thermobimetallic spherical convex membrane, which is deflected in a certain direction in the prescribed temperature range. In this case the electric contacts are closed and the red warning light on the instrument panel of the aircraft lights up. The temperature range, at which the fire detector is activated, is +140° – +170°.

The distributing collector is installed behind the engine and is attached by clamps on the baffle of the inner cowling. The collector is an open ring made of tubes of AMgM alloy with 12 × 10 mm cross section.

On the left removable panel of the instrument display there are installed: test button of the fire warning light, SLTs-45 red fire warning light and button for activation of the extinguisher head of the fire-extinguishing bottle with carbon dioxide CO_2. The button is covered by a protective cap with the inscription "Fire." The cap of the button should always be sealed. On the central electrical panel there is located the AZS-15 fire-extinguishing equipment circuit breaker. All the lines and assembly components of the fire-extinguishing equipment are painted red.

Before every engine start and aircraft departure for a trip it is necessary to check the condition of the fire warning light and the presence of a seal on the fire-extinguishing bottle and the cap with the inscription "Fire."

For checking the condition of the fire warning light it is necessary to:

switch on the battery;

switch on the AZS-15 of the fire-extinguishing equipment;

press the button of the test signal, with this the light should light up with three shining lobes.

In this position (day illumination) the cap of the light should be locked.

The AZS-15 of the fire-extinguishing equipment during engine testing as well as in flight should always be switched on.

With the appearance of a fire from the temperature increase the fire detectors are activated, contacts open and the red fire warning lamp lights up.

For eliminating the fire it is necessary to break off the seal, open the protective cap and press the button with the inscription "Fire." From pressure of the button the pyrotechnic cartridge of the fire-extinguisher head is actuated and the carbon dioxide, which is located in the bottle under pressure, leaves the bottle through the line in the form of mist, enters the collector and through the openings in it fills the engine compartment, due to which the fire is localized.

Fire-extinguishing system SSP-2A. On aircraft from the 172 series a more perfect semiautomatic warning and fire-extinguishing SSP-2A system has been introduced with the installation of nine DPS-1A fire warning sensors instead of the system with two TI sensors. The SSP-2A system is discussed more comprehensively in § 34.

CHAPTER VI

SPECIAL EQUIPMENT OF AIRCRAFT An-2, An-2V and An-2P

§ 32. ELECTRICAL EQUIPMENT

The electrical equipment of the aircraft consists of electric power sources, commutation and control devices, the electrical circuit, and electric power consumers.

The main source of electric power is a GSN-3000 generator working in conjunction with an R-25AM carbon voltage regulator and a differential undercurrent relay (DMR-400D).

The stand-by power supply source on the aircraft is a type 12A-30 storage battery. On the agricultural version of the aircraft two 12A-30 batteries are installed.

All electric power sources work in parallel on the general circuit of the aircraft.

During layover on the ground the aircraft obtains its power supply from airport storage batteries. The airport power supply sources are connected to the on-board system of the aircraft through an airport power supply plug fitted on the left side of the fuselage between frames Nos. 17 and 18. (On aircraft up to the 37th series the plug is located on left side of the aircraft between frames Nos. 23 and 24).

The wiring system on the aircraft - single-wire. All the negative wires are grounded to the fuselage of the aircraft.

In order to reduce radio interference all metallic parts of the aircraft, the assemblies and equipment not having direct contact are connected with each other by cross connections (the aircraft bonding).

The rated voltage of the on-board system during operation of the GSN-3000 generator is equal to 28.5 V, during battery operation - 24V.

Protection of the circuits of the individual consumers of electric power is accomplished by means of automatic circuit breakers (AZS) [A3C] which are used simultaneously as switches and as automatic circuit breakers.

For monitoring the working of the generator and the batteries an amperemeter is included in the circuit of the generator and in the circuit of storage batteries - a voltampere meter.

The voltampere meter - this is a combined instrument which measures voltage and current. Usually it shows the storage battery current, and for measurement of voltage it is necessary to press a button on the front of the instrument panel.

In measuring the voltage of the generator, the storage battery must be switched off.

The voltampere meter has two scales. One - for measurement of voltage (upper) with scale divisions from 0 up to 30V, the other - for measurement of current. This scale - center zero with figures reading 40-0-120 A.

To set the needle to 0 on the instrument there is a mechanical correction screw.

The instrument is placed in a shielded housing and is placed on the pilot's central electrical instrument panel.

§ 33. SOURCES OF ELECTRIC POWER AND CONTROLLING DEVICES

Aircraft Generator GSN-3000

The designation of the generator is deciphered thus: G-generator, S-samoletnyy [aircraft], N-Nizkooborotnyy [slow-speed], with power of 3000 W.

The GSN-3000 generator works as a set with the carbon voltage regulator R-25AM, and the DMR-400D differential undercurrent relay.

The GSN-3000 generator (Fig. 117) is designed for the power supply of the radio equipment of the aircraft and boost charging of the storage batteries in flight.

The GSN-3000 generator is a quadripole, direct current shunt dynamo-machine with four commutating poles.

Basic Specifications GSN-3000

Rated voltage, V....................	28.5
Current, A	100

Power, W (30 V)........................	3000
Revolutions, R/min.....................	3800-6500
Maximum current (for two minutes), A..	150
Maximum power, W.......................	4500
Direction of rotation, looking from the drive shaft.......................	right
Gear ratio from the engine shaft to the armature of the generator.............	2.17:1
Weight of generator, kg................	12.3

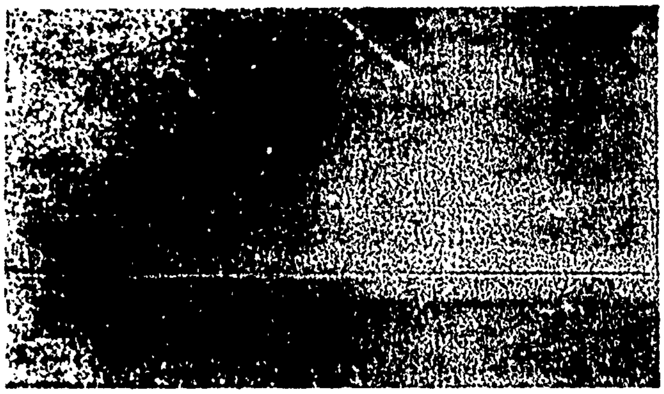


Fig. 117. Generator GSN-3000: 1 - commutator panel; 2 - housing; 3 - flange; 4 - protective strip; 5 - branch connection nut; 6 - branch connection; 7 - crosspiece.

The GSN-3000 generator consists of a housing, poles, commutator panel, armature, brushes, and other parts. The housing of the generator is made from electrical steel. To the housing a panel is welded with a mounting flange of square form. The generator is attached to the rear engine cover behind the flange by four pins. To the housing of the generator there are attached four main and four commutating poles with excitation windings representing the magnetic system of the generator.

Cooling of the generator - forced, by blowing air through a counter current of air which through an air scoop located on the engine cowling enters the generator via a conduit, cools it, and then via two conduits is discharged into the atmosphere behind the cowl flaps. For normal operation of the generator it is necessary that not more than 40 l of air per second pass through it.

Operation of the generator. The GSN-3000 generator during correct operation works smoothly during the entire life of the aircraft engine on the aircraft.

During operation, at the periods provided for by the maintenance regulations, it is necessary to remove the protective strip and to check:

a) the tightening of screw nuts and bolts in the terminal block. In the event of detection of their shaking - tighten them;

b) the correctness of installation and free running of the brushes in the brush holder seats, and also the correctness of the position of the springs which press the brushes to the commutator. The pressure end of spring must always be located within the limits of the groove made in the back of the brush. It is necessary to check the wear of the brushes, removing the brushes from the seats. The normal wear of the brushes after 100 h of operation - 0.7.mm. The full height of brushes reaches 20 mm. If brushes are reduced in height to 18 mm due to wear they must be replaced by new ones;

c) the working surface of the commutator. Normally it has a bluish film. In the event of carbon deposit or oiliness to wear it is necessary to wipe the commutator with a clean cloth moistened in gasoline. If carbon deposit is not removed, clean the commutator with 00 grade sand paper.

Then the generator must be blown with compressed air (1-2 atm) to clean away the brush dust. When replacing the brushes the new brushes are to be rubbed with 00 grade sandpaper. After rubbing the brushes the generator is operated without load for 2 h for final running-in of the brushes.

Storage Battery 12A-30

On the An-2 aircraft one or two storage batteries of the 12A-30 type are installed (Fig. 118). The designation of the storage batteries is deciphered in the following manner: 12 - the number of elements (cells) in the storage battery; A - aviation, 30 - capacity of the battery in ampere-hours at +20°C.

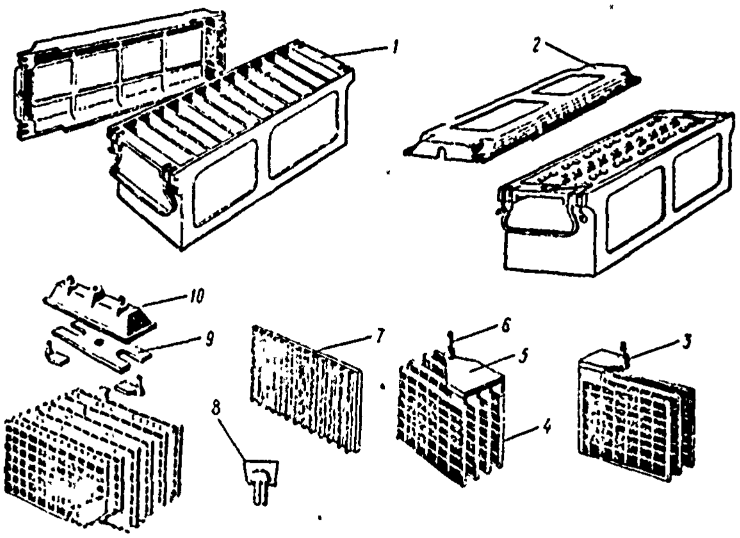


Fig. 118. Storage battery 12-A-30: 1 - ebonite monoblock; 2 - battery cover; 3 - block of positive plates; 4 - block of negative plates; 5 - strap; 6 - terminal post; 7 - separator; 8 - vent plug; 9 - ebonite plate; 10 - cell cover.

The type 12A-30 storage battery consists of 12 series-connected storage batteries (elements) with a total charged state voltage of 25 V.

If two 12A-30 storage batteries are installed on the aircraft, then their total capacity with parallel connection will be equal to 60 A·h.

The storage battery 12A-30 is a reserve power source and is intended:

1) for the power supply of the starting ignition equipment in starting the engine;

2) for the power supply of the aircraft electrical wiring system during slow-running of the engine (taxiing, landing) and for the power supply of the consumers with the engine off when parked;

3) for the power supply of the consumers of electrical power in flight when the generator is out of order.

In joint operation of the generator with the storage battery, the latter is a buffer of the generator, smoothing the peaks of the generator loads.

The 12A-30 storage battery is installed on the aircraft in the tail section in a special aluminum container between frames Nos. 23 and 24. For the removal of the gases which are given off during the operation of the storage battery, a vent tube is connected to the container. The end of the tube is carried overboard.

The battery switch is installed on the electric panel of the pilots' central console.

Basic Specifications 12A-30

Voltage of the charged battery, V	25
Current, 10-hour discharge, A	3
Current, five-minute discharge, A	107
Current, two-minute discharge, A	210
Capacity, A·h	27
End-point voltage on the cell, V	1.7
Weight of battery with electrolyte, kg	27.5
Volume of electrolyte in battery, *l*	3.6
Electrolyte density, g/cm^3	1.285

Structurally the storage battery is made so that, possessing small weight and size, it has a great capacity and sufficient strength. The cells of the battery are enclosed in a pressed ebonite monoblock which ensures airtightness and structural strength. The monoblock is broken down into 12 independent cells. Into each cell there is inserted an individual element which consists of a block of positive plates (three plates) and a block of negative plates (four plates). The plates of identical polarity are connected to one another by connector-straps and have a common terminal post. As an insulation between the plates there are installed ebonite insulation gasket-separators.

The plates are manufactured from pure lead and have a grid form. Into the grids, paste is pressed which consists of lead in powder form, sulfuric acid and water. Positive and negative plates have the same dimensions.

Thickness of plates is 2 mm. The distance between plates is also made small for the purpose of reducing the internal resistance of the cell. Each cell is covered by an ebonite plate and a cap with an opening. All cells are interconnected in series by lead cross connections. The end posts of the cells are connected with the terminals which serve for the connection of the storage battery to the aircraft electrical wiring system.

To ensure airtightness, the storage battery in assembled form is sealed with a special composition.

Into each cell there is poured 0.3 l of electrolyte which consists of a solution of sulfuric acid in distilled water. The level of electrolyte in the cell should be 10-15 mm above the edge of the plates.

Each cell of the battery is provided with a vent plug of special construction which ensures the escape of gases during the operation of the battery and the retention of electrolyte during evolutions of the aircraft. The plug has drainage openings.

Carbon Voltage Regulator R-25AM

The R-25AM carbon voltage regulator (Fig. 119) is intended for the maintenance of a steady voltage of the GSN-3000 generator, equal to 27.5-28.5 V at different engine revolutions and different generator loads.

The R-25AM is installed on the port side of the cargo compartment in special metallic casing and is cooled by a counter airflow which enters through a special air intake.

The R-25AM carbon regulator consists of a carbon pile, electromagnet, base, wiring board, and a rheostat for voltage control. The mounting panel serves for the installation of the voltage

Fig. 119. Carbon voltage regulator R-25AM: 1 - housing; 2 - mounting panel; 3 - rheostat for voltage control; 4 - electromagnet.

regulator on the aircraft and also for the electrical connection of the carbon regulator with the aircraft electrical wiring system.

Adjusting the rheostat serves for voltage control of the generator in flight within limits of +1.5-3 V. In order to change the resistance of rheostat, the head is turned by hand or by a screwdriver.

The principle of operation of the R-25AM carbon regulator consists in the fact that to the excitation winding circuit there is a carbon pile connected in series, whose resistance automatically changes with the aid of an electromagnet depending on the voltage of the generator. The basic winding of the electromagnet of the carbon regulator is connected in parallel with the terminals of the generator. When generator is not working, the carbon pile, with the aid of springs, is in a compressed state.

With an increase in the voltage of the generator up to rated value, for which the regulator has been adjusted in advance, the resistance of carbon pile increases somewhat and with the aid of the electromagnet is kept constant until the number of revolutions or load of the generator changes.

With an increase in revolutions or with a decrease in load the voltage of the generator will be increased, in consequence of which the electromagnet force will grow. This will cause the attraction of the armature of the electromagnet to the core and a decrease in the pressure of the springs on the carbon pile. The resistance of the pile will be increased, and the current in the excitation winding is decreased, and therefore the voltage of the generator is decreased. The armature of the electromagnet occupies a new position in which the resistance of the carbon pile will correspond to the new operating conditions of generator under the assigned voltage.

Conversely, if the revolutions of the generator are reduced or its load increased, then the voltage of the generator at the first moment will be reduced. Then the electromagnet force is reduced, the pressure of springs on the carbon pile will be increased, therefore the resistance of the carbon pile is reduced and the excitation current of the generator and the voltage of the generator will be increased. The armature of the electromagnet of the voltage regulator will assume the new position which corresponds to the new operating conditions of the generator.

In this way, the voltage of the generator is kept constant, equal to 28.5 V at the various operating conditions of the generator.

For improvement in the working of the voltage regulator, there are temperature-compensation and stabilizing resistances in it.

Differential Undercurrent Relay DMR-400D

The DMR-400D differential undercurrent relay fulfills the following functions:

1) automatically connects generator to the aircraft electrical wiring system when its voltage exceeds the voltage of aircraft electrical wiring system by 0.3-0.7 V. If there is no voltage in the circuit (the storage battery has been switched off) or it is below 20 V, the DMR-400D relay works as a regular minimum relay. Switching on of the generator in this case occurs under

a voltage of 13.5-20 V when the load in the aircraft electrical wiring system has a resistance of not more than 6 ohms;

2) automatically disconnects the generator from the aircraft electrical wiring system with a reverse current of 15-35 A;

3) eliminates the possibility of connecting the generator into the network with incorrect polarity on its terminals;

4) provides for manual remote switching on and disconnection of the generator.

Structurally, the DMR-400D consists of four main elements:

1) a differential command relay polarized with the aid of permanent magnets;

2) a direct type contactor with double circuit breaking;

3) an auxiliary double-contact RPR-2A closing relay with circuit closing contacts;

4) a TKE-210B relay.

In the winding circuit of the command relay an additional PO-10 resistance is connected.

All elements of the DMR-400D are fastened to the base with screws.

The auxiliary and command relay are covered outside by a hood.

On aircraft up to the 52nd series, the DMR-400D is installed on top on the storage battery container, while on aircraft after the 52nd series - under the floor of the cockpit.

Basic Specifications DMR-400D

Rated voltage, V	28.5
Rated current, passing through the contactor, A	400
Voltage difference between generator and circuit at which the generator is connected to the circuit, V	0.3-0.7
Reverse disconnection current, A	15-35
Voltage for tripping the contactor and relay at temperature of +20°C, V	not more than 20
Voltage for disconnection of contactor and relay at a temperature of +20°C, V	not more than 5
Operating conditions	prolonged

On aircraft up to the 79th series, DMR-400AM were installed. For the purpose of providing a warning of a break in the main lead of the generator or blowing of the IP-150 protector, on aircraft of the latest series a differential undercurrent relay is installed, the DMR-400D, which differs from the DMR-400AM in the diagram of internal connections, and by the presence of an additional "B" terminal, and by the use of a TKE-52PD external relay. The DMR-400D can be used instead of the DMR-400AM relay, in so doing it necessary to install a cross connection between the "B" and the "BAT" terminals.

Testing the Electric Power Sources Before Flight

To test the direct current power sources it is necessary:

1. To connect the storage battery and to connect a load of 6 A (RV-2 or headlight) and to measure voltage on the aircraft voltmeter. It should not be below 24 V.

2. After starting and warming-up the engine to check the operation of the generator and controlling equipment, to do this,

smoothly increasing the engine revolutions, watch the generator light. At 900-1000 r/min of the engine the generator light goes out. This testifies to the fact that with the aid of the DMR-400AM the generator was connected to the aircraft electrical wiring system. The voltage of the generator in this case should be within limits of 24.5-26.5 V.

3. Increasing the engine revolution, watch the voltage of the generator. Voltage should rise to 28.5 V and with a further increase in the engine revolutions to maximum, the voltage should remain steady and equal to 28.5 V. This will attest to the normal operation of the R-25AM voltage regulator.

4. With the generator and storage battery connected, at engine revolutions of 1700-1800 r/min, connect a load (PO-500, ARK-5, RSIU-3M, RSB-5). The voltage of the generator should remain constant within limits of 27.5-28.5 V and the ammeter should show the current of the generator load.

5. To check the DMR-400AM on disconnection, for which, smoothly reducing the engine revolutions, watch the readings of the ammeter of the generator. As the engine revolutions decrease, the needle of the ammeter of the generator is moved from right to left to 0, passes 0 and with reverse current of 15-35 A the needle of the ammeter abruptly stops at 0, the generator light goes on - the generator is disconnected from the aircraft electrical wiring system. This attests to the normal operation of the DMR-400AM.

6. In flight, the generator and storage battery should be connected, therefore it is necessary to periodically check their operation with two instruments: the ammeter of the generator and the voltampere meter of the storage battery.

In normal operation of the power sources the needle of the ammeter of the generator should be deflected to the right of 0, showing the current of the generator load, and the needle of the voltampere meter of the storage battery - to the left of 0, showing the current of the booster charge of the storage battery, if storage battery was discharged, or to stay on 0, if the storage battery is charged.

If in flight, the generator light goes on, then this means that the generator is defective and has been disconnected from the aircraft electrical wiring system. The power supply of the consumers of electric power in this case will be accomplished from the storage battery. In the event of failure of the generator it is necessary to leave connected to the aircraft electrical wiring system only the minimum necessary number of consumers in order that the charge of the storage battery will be sufficient for landing. The RSB-5 and RSIU-3M radio sets and the ARK-5 radio compass must be switched on in this case only for a period of communications or direction-finding, the PO-500 converter and the RUK-300B dynamotor which supply their current are heavy users of electric power. Much electric power from the aircraft electrical wiring system is also taken away when the electric heated windows are turned on.

If on landing with the throttle back the needle of the ammeter of generator is deflected to the left to the stop, and the needle of the voltampere meter of storage battery - is to the right to the stop and remain in such a position, then this means that the power contacts of the DMR-400D are sealed and the discharge of the storage battery is going to the generator. The condition is a fire hazard. In such a situation it is compulsory to disconnect the storage battery.

Centralized Single-Phase Alternating Current System

For the radio equipment power supply (ARK-5, US-9DM, SPU-6 and RSIU-3M) on An-2 aircraft, beginning with the 94th series, a centralized single-phase alternating current system with voltage of 115 V with a frequency of 400 Hz is used.

The power sources of this wiring are two converters of the type PO-500 (one - the main, the second - a backup). Both converters are located under the floor of the cockpit. The working one - between frames No. 4 and 5, the spare - between frames No. 1 and 2. Access to them is through the hatch in the floor between the pilots' seats.

The converters are switched on by the PO-500 switch on control panel, which has three positions: "Working" - "Switched off" - "Spare". In the event that the spare converter is switched on, on the control panel next to the switch a warning light goes on.

If the converter switch has been put in the "Working" position and in so doing the warning light goes on, then this means that the operating PO-500 converter has failed and the spare PO-500 converter has been automatically connected. The automatic change-over from operating converter to spare is produced by the KPR-1 box mounted on frame No. 1 under the floor.

The PO-500 converter is intended for conversion of the direct current of the aircraft electrical wiring system with a voltage of 27 V into alternating current with a voltage of 115 V with a frequency of 400 Hz. It consists of a unit with self-ventilation. From the low voltage side it is a d-c electric motor, while from the high voltage side - a synchronous single-phase a-c generator. Both these units are mounted on one armature and are placed in one housing. On top on the housing of the converter a box is installed with the starting-control equipment and filters.

Basic Specifications PO-500

Supply voltage, V........................	27 ± 10%
Consumed current, A.....................	39.5
Output alternating voltage, V...........	115 ± 4%
Frequency, Hz............................	$400^{+7}_{-3}\%$
Output power, VA.........................	500
Return alternating current, A............	4.35
The mode of operation....................	prolonged
Revolutions, r/min.......................	12,000
Weight, kg...............................	12.5

Alternating voltage from the PO-500 converter is supplied to the "RK-115 V" distributing head located at frame No. 5 under the radio equipment. In this box, glass-sealed fuses (SP-1, SP-2, SP-5) are installed through which alternating current is supplied to the consumers.

Monitoring of the alternating current circuit voltage is performed with a type EV-46 voltmeter installed on the pilot's instrument panel.

The centralized network of single-phase alternating current has been carried out in single-wire. One phase of alternating current is connected directly to the metal fuselage at the place of installation of the converter. The second phase is brought out by a separate shielded conductor.

The PO-500 converter must be switched on after load has been switched on an alternating current (ARK-5, RSIU-3M, etc). If the PO-500 converter is switched on without load, then the revolutions of its armature may reach the limit. In this case, the centrifugal switch trips and disconnects the converter in emergency. In order to again switch on the emergency-disconnected converter it is necessary to press on the centrifugal switch button located on the front part of the housing of the converter.

During operation in the periods provided by the An-2 aircraft maintenance regulations it is necessary to inspect the commutation and brush assembly, to blow brush dust from the converter and to check the height of the brushes. Brushes whose height has been reduced in the direction of the alternating current to 10 mm and in the direction of direct current - to 18 mm are replaced by new ones.

A periodic check of converters for compliance with the standards of the main technical parameters is produced in the laboratory.

Centralized Three-Phase Alternating Current System

For the power supply of aircraft instruments (AGK-47B, DGMK, GPK-48, GIK-1M) on An-2 aircraft beginning with the 94th series, a centralized three-phase alternating current system with voltage of 36 V with a frequency of 400 Hz has been used. The source of electric power of this system is the PT-125Ts converter which is installed under the floor of the cockpit.

An emergency power source of three-phase current for the AGK-47B gyrohorizon of the left pilot and the GPK-48 is a converter of the PAG-1FP type. It also is installed under the floor of the cockpit.

Switching on the PT-125Ts converter is accomplished by a 2V-45 switch on central control panel.

The PAG-1FP converter does not have a separate switch and is switched on by the AZS-5 automatic circuit breaker on the central control panel together with the switching on of the left pilot gyrohorizon.

The PT-125Ts and PAG-1FP are intended for conversion of the direct current of the aircraft's 27 V system into alternating three-phase current of 36 V with a frequency of 400 Hz.

The converter consists of a d-c electric motor and a synchronous three-phase a-c generator mounted on a common armature and set in one common housing. On top on the housing of converter a case is installed with the control apparatus and filters.

Basic Specifications PT-125Ts

Supply voltage (direct current), V.........	27 + 10%
Consumed current, A........................	not more than 8
Output alternating voltage, V..............	36
Rated load current, A......................	2
Alternating current frequency, Hz..........	400
Effective output, VA.......................	125
Number of generator phases.................	3

Alternating three-phase current from the PT-125Ts converter is supplied to the "RK-36 V" distributing head located on the partition of frame No. 5 under the radio equipment. In this box, SP-1 glass-sealed fuses are installed (each aircraft instrument has three fuses) through which alternating three-phase current is supplied to the consumers.

Basic Specifications PAG-1FP

Supply voltage (direct current), V.........	27 ± 10%

Consumed current, A	not more than 3.5
Output alternating voltage, V	36 ± 3.6
Rated load current, A	0.85
Alternating current frequency, Hz	400 ± 40
Effective output, VA	53
Number of generator phases	3
Weight, kg	3.5

During operation in the periods provided by An-2 aircraft maintenence regulations, it is necessary to check the condition of the brushes and commutator and to blow brush dust from the converters with compressed air at 1-2 atm from a portable cylinder. The converters are checked periodically in the laboratory.

In the case of wear of the brushes of PT-125Ts converter to 12 mm and below, they must be replaced by new ones. For the PAG-1FP, wear of the brushes to 10 mm.

§ 34. ELECTRIC POWER CONSUMERS

The electric power consumers on the aircraft are:

1) engine starting and ignition units;

2) the UT-6D aileron trim tab control mechanism;

3) the UT-6D elevator trim tab control mechanism;

4) the UT-6D rudder trim tab control mechanism;

5) the UR-7M cowl flap control mechanism;

6) the UR-7M oil cooler flap control mechanism;

7) the UZ-1A (UZ-1AM) upper wing flap control mechanism;

8) the UZ-1A (UZ-1AM) lower wing flap control mechanism;

9) electrical aircraft instruments (the complete assembly);

10) the cockpit and compartment lighting, and the door warning;

11) FS-155 landing lights;

12) FR-100 taxilight;

13) UFO in the ARUFOSh fixture (7 sets);

14) Pitot tube (PVD) heating;

15) AS-2 electric windshield wipers;

16) electric window heating;

17) BPK-4 electric fuel pump;

18) the EKR-3 electromagnetic dilution valve;

19) the fire warning;

20) the power supply of the RSB-5, RSIU-3M, ARK-5, RV-2, SPU-5, MRP-48P or MRP-56P radio sets.

Engine Starting Units

For starting the engine an electric inertia starter RIM-24IR is installed on the aircraft. Electric inertia starters are so called because they use the energy of a rapidly rotating flywheel which is then transferred through a friction clutch, reduction gear, and coupling mechanism to the shank of the engine crankshaft. The starter is attached to the rear engine cover in the center.

The complete set of the engine starting units include:

1) SA-189 electric motor;

2) RA-176 ratchet relay;

3) VM-177 magnetic switch or K-300D contactor;

4) KS-3 starter button or PN-45M switch;

5) KP-4716 starting coil;

6) AZS-20 starter circuit breaker.

Control of the electric starter is remote and is accomplished from the cockpit. An electric starter motor of the SA-189 type is designed for spinning the flywheel of the starter. The SA-189 electric motor is series-wound and develops 12,000-18,000 r/min during starting. The normal mode of operation of the electric motor - 20 seconds of operation and a 20 second break, whereupon, after three such cycles, a prolonged break is mandatory because the value of the starting current reaches 140 A and frequent engagement will lead to overheating of the electric motor and the connecting wires.

The magnetic switch VM-177 attached to the starter housing or to frame No. 1 is intended for connection of the power supply of the electric motor. The mode of operation of the switch is also cyclic: 20 seconds of operation, 20 seconds of break (for cooling), after three connections the circuit should be switched off for complete cooling of the switch. Premature connection of the switch can lead to overheating and even to burning of the contacts.

The RA-176 ratchet relay is attached to the starter housing and serves for engaging the ratchet of the starter with the shank of the crankshaft of the engine.

The starting coil, KP-4716, mounted on the strut of the engine frame, serves for the supply of high voltage at the moment of starting the engine.

The KS-3 starter button (or PN-45M switch) serves to connect the starting relay of the electric motor, the starting coil, and the ratchet relay.

The engine must be started in the following sequence:

1) switch on the airport power source;

2) switch on the AZS-20 on the pilot's electrical panel;

3) pull out the button marked "Starter" "Towards you" and retain it in this position for 8-10 seconds in summer and 16-20 seconds in winter. In so doing, current will go from the storage battery to the winding of the BM-177 magnetic switch.

The magnetic switch triggers and pulls the core with the contacts which close the feed circuit of the SA-189 electric motor.

The electric motor, developing revolutions, will rotate the flywheel of the starter;

4) when the electric motor has the necessary number of revolutions, press the KS-3 button "From you". In so doing, the feed circuit of the magnetic switch will be disconnected, the electric motor deenergized, and current will simultaneously go in two directions:

to the winding of the RA-176 ratchet relay. The relay trips and engages the ratchet of the starter with the shank of the crankshaft of the engine. The crankshaft of engine will begin to turn at a rate of 80-90 r/min;

to the primary winding of the KP-4716 starting coil. The core of the coil will be magnetized and will pull the movable reed. In so doing the power supply circuit of the primary winding will be disconnected, the core will be demagnitized and will release the reed which will again make contact. And thus there will always be closing and opening of the circuit of the primary winding of the coil (the mode of an electric bell).

Thanks to this, the secondary winding of the KP-4716 coil will be intersected by a variable magnetic field and in it a high-tension current will be induced which enters the distributor of the magneto and further to the spark plugs, on the contacts of which will appear the spark which ignites the mixture.

It is forbidden to start the engine if the ratchet of starter is engaged with the shank of the engine crankshaft without first spinning up the starter because in so doing the armature of the electric motor will not be able to rotate, current will be too great, and the windings of the electric motor can burn up. It is forbidden to repeat starting more than 3 times in a row. If after the third attempt the engine does not start, it is necessary to take a break of 20-30 min to cool the starter.

Remote Control Electrical Mechanisms

Electrical Mechanism UT-6D

On the aircraft three UT-6D electrical mechanisms are installed:

1) the UT-6D aileron trim tab control electrical mechanism located in the left aileron;

2) the UT-6D rudder trim tab control electrical mechanism located in the rudder;

3) the UT-6D of elevator trim tab control electrical mechanism located in the left elevator.

Access to all UT-6D mechanisms is provided through the corresponding inspection hatches.

The UT-6D electrical mechanism as compared with UT-3 mechanism, installed on aircraft up to the 37th series, is economical, and weighs less. The UT-6D electrical mechanism consists of the following main units:

1) a reversible d-c electric motor with power of 4 W at 7000 r/min;

2) a reduction gear with external engaging gears with a gear ratio of 3749:1;

3) a friction clutch for limitation of load;

4) a rack placed at right angles to the axis of the mechanism;

5) a contact device for the trim tab neutral position warning light;

6) a terminal panel.

The UT-6D electrical mechanism is made covered and shielded and can work in any position: vertical, horizontal, and tilted.

Basic Specifications UT-6D

Rated voltage, V......................	27
Range of operating voltage, V.........	23.4-29.7
Current consumed under load on rack of 20 kg, A..........................	0.75
Rated load on rack, kg................	20
Maximum load on rack, kg..............	40
Stroke of rack, mm....................	21.6
Time of operation of trim tab from one extreme position to the other, s......	30
Mode of operation, intermittent:	
number of working operations........	10
break between operations, min.......	1
Weight of unit, kg....................	1

Control of the UT-6D electrical mechanisms is exercised by the PN-45M pressure switches installed on the central control panel.

Pressing the PN-45M closes the windings of the electric motor. The armature begins to rotate and with the help of a splined connection with the gears of the reduction gear imparts rotation to the reduction gear which moves the movable rack under axial stress. The rack imparts motion to the trim tab by means of hinged rod and guide.

Pressing the PN-45M in the opposite direction closes the counter clockwise rotation circuit of the mechanism and the trim tab will be deflected in the opposite direction. When the handle of the PN-45M switch is released the feed circuit of the electric motor is opened and the motion of the trim tab ceases.

With neutral position of the trim tab a warning light lights up on panel next to the corresponding switch.

At the maximum deflection of the trim tab, which corresponds to the extreme position of the rack, slippage of the friction clutch occurs, the movement of the trim tab ceases, but the electric motor will continue to rotate as a result of the slippage of the clutch until its power supply circuit is opened. To stop the electric motor it is necessary to discontinue pressing the PN-45M switch (to release it).

Electrical Mechanism UR-7M

On the aircraft two UR-7M electrical mechanisms have been installed;

1) the UR-7M electrical mechanism to control the cowl flaps, located on the first frame on the cockpit side;

2) the UR-7M electrical mechanism to control the flaps of the tunnel of the oil cooler, located on the detachable flap attachment housing.

The UR-7M electrical mechanism consists of the following units:

1) an MU-320 reversible d-c electric motor, two-pole, series-wound, power 100 W at 5500 r/min;

2) an EMM-2 electromagnetic coupling, intended for stopping the engine after switching off;

3) worm and planetary reduction gears for reducing the number of revolutions of the electric motor and for increasing torque on the output gear. The overall gear ratio of the UR-7M mechanism is 4790:1;

4) a limiting device, used for the automatic cutoff of the electric motor when the flap reaches its extreme position.

Basic Specifications UR-7M

Maximum torque, kgf·cm................	600
Mode of operation.....................	intermittent (1 min operation, 10 min break).
Supply voltage, V.....................	26
Weight of electrical mechanism, kg....	2.8

For protection of both UR-7M electrical mechanisms in their circuits there is one AZS-10 each.

The electrical mechanisms are controlled by PN-45M pressure switches located on the central panel. The position of the oil cooler flap is controled by a UPZ-48 instrument located on the central panel.

Electrical Mechanisms UZ-1A and UZ-1AM

Two UZ-1A electrical mechanisms serve for remote control of the upper and lower flaps. The mechanism for the upper flaps is located between frames Nos. 8 and 9 in the upper part of the fuselage. The mechanism is enclosed by a readily detachable housing.

The mechanism for the lower flaps is installed between frames Nos. 8 and 9 under the cargo floor. Access to it is through a swing-away hatch cover.

The UZ-1A electrical mechanism consists of the following units:

1) a reversible d-c electric motor of the MUK-421 type;

2) a reduction gear with a gear ratio of 1:40;

3) a screw ball-bearing pair.

The MUK-421 electric motor is a quadripole d-c motor with series excitation. The MUK-421 motor is reversible. For reversal, there are two independent excitation windings in it hooked up separately.

Switching on of the electric motors into the system is accomplished by a 205-K push button with the help of an RRT-40 relay.

Basic Specifications UZ-1A

Mode of operation....................	intermittent
Supply voltage, V......................	26
Current, A.............................	20
Rated axial load, kg...................	350
Maximum axial load, kg.................	750
Weight, kg.............................	5.2

The reduction gear consists of a worm pair and serves to increase torque and reduce the number of revolutions.

The operating principle of the electrical mechanism is that the rotation of the armature of the electric motor through a splined connection is transferred to the worm; the worm transfers rotation to the worm gear connected with a screw which, rotating, ensures the progressive movement of the nut with the working rod.

In extreme positions, the UZ-1A electrical mechanism is shut off with the help of MVSh-2T end switches.

In the flap control circuit there are two RRT-40 relays (one for each mechanism) used for remote cutoff of reversal and to provide for electrodynamic braking at the moment the MVSh-2T end switch is tripped.

Protection of the electrical mechanism is carried out by three AZS installed on the board of the instrument panel. One AZS-5 is installed in the control circuit of the mechanisms and two AZS-15 - in the feed circuits of the upper and lower UZ-1A.

To extend the flaps it is necessary to switch on all three AZS on the shield and to press the button 205-K on gas quadrant. To retract the flaps it is necessary to press the 205-K button on central control panel with the inscription "Flaps up". When using the flaps separately the two AZS on the shield are connected.

The UZP-47 instrument controls the position of the upper flaps. The instrument indicator is placed on the upper panel of the central control console.

During the operation of the UZ-1A electrical mechanism it is necessary to pay special attention to the correctness of its mounting, fastening, and locking, and also to the precision of action of the RRT-40 and the MVSh-2T.

To eliminate jamming of the screw ball-bearing pair in the extreme positions it is necessary in mounting the electrical mechanism on aircraft to ensure a margin of run to inertial overshoot.

Possible malfunctions of the electrical mechanism:

1) jamming of the brush in the yoke of the brush holder;

2) breakdown of the power supply circuit;

3) fouling of the commutator by brush dust;

4) jamming of the reduction gear or the screw ball-bearing pair;

5) jamming of the contacts and misadjustment of the RRT-40.

In connection with occurring defects and failures of the UZ-1A electrical mechanism on the An-2 aircraft, the units of the electrical flap control equipment UZ-1A, RRT-40, and MVSh-2T are replaced by a combined UZ-1AM electrical mechanism, in which the RRT-40 relay and MVSh-2T end switches have been eliminated.

Instead of the RRT-40 relay in UZ-1AM electrical mechanism to reduce inertial overshoot an electromagnetic drive-braking coupling of the electric motor is used. To limit the run of the rod, in the mechanism there is a block of V-611 type end switches.

The time required to extend and retract the flaps from the UZ-1AM mechanism is 14-15 s. The UZ-1AM electrical mechanism is interchangeable with the UZ-1A mechanism in respect to fitting dimensions but is not interchangeable in respect to the circuit diagram.

Electric Fuel Pump BPK-4

The BPK-4 electric fuel pump is intended for fueling the aircraft with fuel from drums under field conditions on aero-chemical operations. To do this to the pump pipe a hose is connected, the other end of which is put into the drum containing fuel. In so doing, the switch on the unit itself must be set in the "Fueling" position and the AZS mounted on the left panel must be switched on.

The BPK-4 pump is installed under the left pilot's floor. Access to the pump is gained through the large lower hatch of the fuselage.

Protection of the electrical circuit of the pump power supply is carried out with the help of an AZS-15 installed on the left panel.

The BPK-4 pump is switched on to operate by a V-45 switch mounted on frame No. 2 under the floor of the cockpit.

Basic Specifications BPK-4

Electric motor, driving the pump........	D-200
Rated number of revolutions of the shaft of the electric motor, r/min............	2750
Rated moment, kgf/cm....................	7
Working fluid...........................	aviation gasoline
Pump capacity at outlet pressure of 0.2 kgf/cm^2, l/h	3200
Voltage across terminals of electric motor, V..................................	27

Heating PVD-6M

The pitot tube PVD-6M is provided with an electrical heating element which is supplied from the d-c system. The current consumed by electrical heating element amounts to 3.4 + 3.9 A.

The PVD-6M heating is connected on the AZS electrical panel with the help of an AZS-5. The functioning of the electric circuit is checked with the help of a switch and a light, placed on the instrument panel. When the heating monitoring switch is turned on the signal light goes on.

Electric Windshield Wipers AS-2

The two sets of AS-2 windshield wipers installed in the cockpit of the aircraft are intended for removal of raindrops, snow, and ice from the windshields of the cockpit.

Both AS-2 mechanisms are placed on frame No. 1 and they are switched on to operate by means of V-45 switches on the left panel.

Protection of the wiring of the electrical mechanisms of the AS-2 is accomplished by one AZS-10 on the left panel.

The AS-2 windshield wiper (Fig. 120) is a unit consisting of its electric motor 4, flexible shaft 2, reduction gear 3 with worm and rack pairs and a guide with a rubber wiper 1.

Basic Specifications AS-2

Accessory

Voltage, V............................	27
Current consumed during operation, A..	2.5
Power consumed, W...............	not more than 68

Number of revolutions, r/min.............	6400
Mode of operation........................	prolonged
Weight, kg...............................	1.9

Electric Motor

Moment on the wiper shaft, kgf·cm........	not more than 15
Force of wiper pressure on object , kgf..	0.4-1.1
Maximum weight (with motor), kg..........	2.1

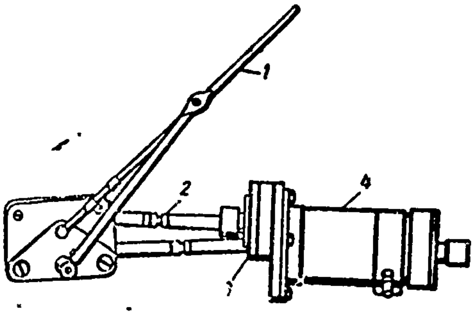


Fig. 120. Windshield wiper AS-2.

The operating principle of the windshield wiper consists in the fact that the rotary motion of the shaft of the electric motor is converted into a reciprocating motion of the rack engaged with the gear of the wiper shaft. Because of this, the gear with the shaft, rotating in both directions within the limits of an angle of about 112° turns the arm with the wiper pressed by leaf springs to the cockpit windshields in both directions. During operation the AS-2 unit makes 70 sweeps per minute.

Electromagnetic Oil Dilution Valve EKR-3

The EKR-3 electromagnetic valve for diluting the oil with fuel is intended for bypassing of fuel from the fuel system into the oil system. It is a valve of the solenoid type. Inside the cast housing with inlet and outlet ducts and a bypass opening there is an electromagnetic coil. In the "off" position the bypass opening is closed by a rubber valve on which a spring exerts pressure. When the valve is actuated, the armature under the action of the magnetic field of the solenoid, overcoming the force of the spring, is pulled and opens the bypass opening. As a result of this, fuel from the inlet duct pours into the outlet duct and further on via tubes will enter the oil outlet nozzle from the oil cooler.

The capacity of the valve with a pressure of 0.2-0.3 kgf/cm^2 in the fuel system of the aircraft is 2 liters of fuel per minute. The EKR-3 electromagnetic valve is located on the firewall. The electric valve is controlled with the help of an AZS-5 located on the left panel.

Electric Window Heating

Electric heating of the windows is designed to counteract icing and misting. The electrically heated windows are triplex, consisting of two tempered silicate panes, a Butvar film between them, and an electric heating element of thin constant wires.

The electrically heated windows obtain current from the on-board circuit with a voltage of 27.5 V, with power consumption of 800 to 1130 W. If the windows are turned on on the ground at plus temperatures of air (without heat removal), then the specific power of the glass is so considerable (from 0.47 to 0.58 W per 1 cm^2 of heated surface) and its temperature can rise to such a value that the glass will be covered with bubbles or it will crack. To prevent this phenomenon, the power supply of the windows is controlled by an AOS-81M heating circuit breaker.

Control of the supply of current to the electrically heated windows is produced automatically by means of TOS-1 thermistor sensors pressed in the windows, and by the AOS-81M automatic circuit breaker.

The electric heating assembly of the windows includes:

1) T-21 electrically heated glass - 2 pcs.;

2) the AOS-81M automatic control - 1 pcs.;

3) KM-50D switch contactors - 2 pcs.;

4) V-45 window switches - 2 pcs.;

5) AZS automatic circuit breakers (AZS-20, AZS-25, AZS-5).

The AOS-81M control automatic is located between frames No. 3 and 4 on the port side under the floor of the cockpit.

To use the electrically heated windows it is necessary to switch on the AZS-2 and the V-45 switches. It is necessary to use the electric window heating in flight when there is danger of icing and misting (before penetrating overcast, and in haze and fog). In flights under adverse weather conditions it is recommended that heating of the windows be turned on during the entire time of flight. When the aircraft is standing on the ground, window heating should be used only in the case of their external icing.

In normal operation of the AOS-81M, the temperature of the external surface of the windows should not rise above 25°C.

Lighting Equipment

All the lighting equipment is subdivided according to purpose into three groups:

1. Landing-takeoff light facilities which ensure taxiing, takeoff, and landing at night. These include the taxiing and landing lights and pyrotechnic facilities - flares.

2. The inner illumination installations necessary for the normal work of the crew at night and for creation of the necessary passenger conveniences. They include the sources of visible light and ultra-violet radiation intended for illumination and irradiation of the instrument panel and individual instruments; the sources of visible light for the illumination of the work stations of the crew, the passenger compartment and auxiliary positions; and portable illumination.

3. The light signaling facilities: interior and exterior. Interior facilities are intended to provide a signal for a fire-fighter jump landing, for monitoring the state and working of the various devices on the aircraft. Exterior facilities are designed to mark the overall dimensions of the aircraft, for light signal communication between the aircraft and the ground and for communications between aircraft in night flight.

For exterior signaling use is made of the navigation lights, code lights and pyrotechnic signal flares; for interior - a signal lighting fixture with colored filters.

Takeoff-Landing Lighting Facilities

Taxilight FR-100 . For illumination of the area ahead during taxiing, on the An-2 aircraft one FR-100 taxilight is installed in a recess in the edge of the left half of the lower wing next to the landing light. On top the light is enclosed in plexiglass.

The FR-100 aircraft taxilight consists of a metallic housing covered externally by a protective lens. Inside the housing a receptacle with a light and reflector is fastened. On the outside a hinged support held in place by an adapter nut is attached to the housing.

The FR-100 taxilight is switched on by an AZS-5 switch installed on the pilot's electric panel.

Basic Specifications FR-100

Voltage, V	28
Power, W	100
Maximum candle power, cd	5000
Angle of diffusion in horizontal plane, deg	30

Landing lights FS-155. Two FS-155 lights are designed to provide for landing under night condition. The lights are installed on hinged brackets in the leading edges of the lower wing. The light compartments are covered by a plexiglass cover. The installation of the lights is produced at the factory in special patterns in such a way that their optical axes with a three-point position of aircraft intersect in front of the aircraft at a distance of 57 m and to the left of the longitudinal axis of the aircraft - at a distance of 6 m.

The lights are connected separately by an AZS-15 automatic circuit breaker installed on the shield of the instrument panel.

The installation angles of the lights are shown in Fig. 121.

Installation of Interior Lighting

For illumination of the cockpit, instruments, passenger cabin

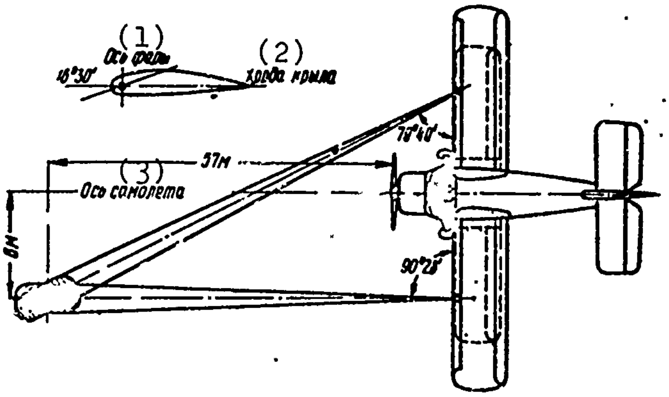


Fig. 121. Installation angles of lights on the aircraft.

KEY: (1) Axis of light; (2) Wing chord; (3) Axis of aircraft.

and auxiliary compartments, interior lighting is employed. The cockpit lighting with the equipment located in it plays a special role in night flights.

The cockpit and instrument panel are illuminated with ultra-violet irradiation and white light lamps. UFO-4A lamps in an ARUFOSh-45 fixture are used as ultra-violet sources. Near the ARUFOSh-45 fixture are mounted RUFO-45 rheostats. Each lamp is connected through an independent rheostat.

On the aircraft, seven sets of ultraviolet lamps are installed. Two lamps fastened to the right and left sides illuminate respectively the right and left panels of the instrument panel. Two lamps are attached to the lateral walls of the central console and illuminate the instrument panels. Two lamps are mounted on a rotary rod and illuminate the central console. One lamp on the left side is intended for the illumination of the left panel. All the explanatory stencils are coated with a temporary acting, glowing mass and are quite visible when irradiated by ultra-violet light.

The ARUFOSh-45 assembly includes the fixture with hinged attachment, inside which is placed a luminescent gas-charged lamp (Fig. 122) and a rheostat for turning on and controlling the intensity of the light flux emitted by the lamp.

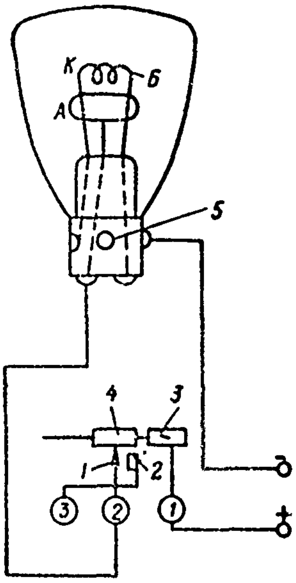


Fig. 122. Luminescent lamp UFO-4A and its electrical connection circuit: A - anode; B - bimetallic plate; K - cathode; 1 - starting-adjusting rheostat contact; 2 - spring stop; 3 - ballast resistance; 4 - adjustable resistance; 5 - upper base prong.

Inside the housing there are found two light filters of dark ultraviolet glass. Both filters each have two sector-shaped cuts at an angle of 90°. The lower light filter is fastened to a cylindrical adapter, the upper - to a swivel head. In connection with this, by rotation of the head of the fitting it is possible to cover either all four sectors, or two sectors in two layers with the dark ultraviolet glass.

When all four sectors are closed an invisible ultra-violet current is used which, irradiating a luminous composition on the scales of the instruments, causes them to light up.

When two sectors are covered along with the ultra-violet current, visible blue light is also used. By controlling the opening of the sectors it is possible to achieve the desired illumination in order to avoid a sharp contrast between illumination in the cockpit and surrounding space.

The UFO-4A lamp (Fig. 122) is a conical bulb. The inside of the bulb is coated with a thin layer of luminescent composition. Inside the lamp bulb there is a cathode K in the form of a tungsten spiral and an anode A in the form of ring. In cold state the cathode and anode are connected to each other by bimetallic plate B. The lamp bulb is filled with mercury and argon vapors under low pressure.

Control of the lamp is accomplished by an RUFO-48 rheostat.

To light the UFO-4A lamp it is necessary to turn the knob of the rheostat to the right to the stop. The lamp does not light up immediately but in 10-15 s after being switched on. This time is necessary for preheating the mercury and argon vapors.

The principle of the ignition of the lamp consists of the fact that when the lamp is turned on, current from the plus busbar passes through ballast resistance 3, rheostat contact 1 to the anode of the lamp and further through the bimetallic plate to the negative of the aircraft circuit. The filament of the lamp, incandescing, will heat the mercury and argon vapor and the bimetallic plate. The latter bends on heating and in 10-15 s it opens the feed circuit of the filament of the lamp. At the interruption an arc discharge appears between the heated anode and cathode. The mercury vapor begins to lignt up and the lamp emits a light flux.

To shut off the lamp the knob of the rheostat must be turned to the left to the stop.

After switching off a lamp which has burned for 10 min and more, the bimetallic plate will cool off only after 2 min and will make the circuit between cathode and anode. After this the tube can again be turned on.

Basic Specifications UFO-4A

Voltage, V............................	26-28
Current, A............................	0.35
Power, W..............................	4

The white light cockpit lights in fixtures of the KLSRK-45 type, installed on left and right sides, serve for illumination of the crew's chart-holders. If necessary, these lamps provide illumination of the instrument panels. In a KLSRK-45 fixture there is installed a single-contact lamp of 4.75 W power.

The KI-12 compass and the control panel of the radio compass have individual illumination. In the circuit of the illuminating lamp of the KI-12 compass to reduce the brightness of the light flux an RIK-49 rheostat is connected in series installed over the instrument panel.

For illumination of the space behind the instrument panel a white light lamp in a KLS-39 fixture is installed. The lamp is automatically switched on by a VK-2-142G switch when the central shield of instrument panel is opened.

A P-39 dome light provides illumination for the communications located under the floor of the cockpit. It is switched on automatically by a VK-2-142G switch when the hatch is opened. Protection of the feed circuits is carried out by an automatic circuit breaker (AZS).

The P-39 dome light consists of a metallic housing, the inner surface of which serves as a reflector, a lamp socket with a two prong lamp installed in it and a lens. The dome light is attached with three screws through openings in the collar of the dome light. In the P-39 dome lights spherical lamps of 15 W power are installed.

Illumination of the cargo compartment is accomplished by two P-39 dome lights mounted on the skin of fuselage from above near frame Nos. 6 and 14. The illumination of radio equipment installation is accomplished by KLSRK-45 lamp, installed on frame No. 7.

Basic Specifications P-39

Lamp voltage, V....................	28
Lamp power, W.......................	15
Light flux, lm.....................	15
Type of "Swan" (bayonet) base......	"Minion"

The tail compartment is illuminated by a P-39 dome light installed on frame No. 15. The dome light is switched on by a V-45 switch, located next to the dome light on the side of the cargo cabin.

For portable illumination, three sockets are provided, placed near the central distributing board [TsRSh], in the centerplane over the inspection hatch for condensate drainage from the PVD installation, and on the right side at frame No. 15.

Light Signaling Facility

The navigation lights (ANO) consist of BANO-45 navigation lights (side ANO) and a KhS-39 tail light. The BANO-45 are installed on the ends of the upper wing panels.

The construction of the BANO-45 includes: SM-22 lamp, a base with receptacle, a glass cover of red or green color, a rubber gasket and central screw to fasten the cover. The rubber gasket ensures good airtightness. The cavity of the cover inside the back part of the lamp has a frosted surface. The lamp bulb has a partially mirrored surface.

Basic Specifications BANO-45

Voltage, V	28
Power, W	24
Candlepower, cd	21
Cover	red or green

The tail light KhS-39 is mounted on the trailing edge of the rudder and is fastened by three screws. The light fixture consists of a housing with socket, a mounting for attaching the glass cover and double-contact "Swan" receptacle.

Basic Specifications KhS-39

Voltage, V	28
Power, W	10
Candlepower, cd	2.5
Receptacle	"Swan" 2S-15

Inside the aircraft on the partition at frame No. 15 on top over the door of the tail compartment there are three dome lights with green, red and yellow light filters. Switching on of the corresponding signaling dome lights is produced by pressing one of the three 205-K buttons painted green, red, and yellow which are located on the right vertical wall of the central control panel.

Formation lights PSSO-45 are installed on the aircraft after the 37th series and are intended for signaling between aircraft flying in formation. The number of lights - 10. They are arranged in the following manner: three lights in one row on the lower skin of the fuselage; three lights in one row on the upper skin of fuselage; two lights on the upper wing; two lights on the lower wing. The lights are connected by V-45 switches.

On the aircraft provision is made for warning of an open position of the cargo and passenger doors, which is accomplished by a VK-2142G switch which operates on breaking, and by a signal light in an SLTs-45 fixture with a red light filter. The switch is mounted on the door frame, the SLTs-51 fixture - on the central panel. When one of the doors is open a warning light on the central panel lights up.

For audio signaling, on frame No. 6 an S-1 siren is installed which is activated by a 205-K button on the central control panel.

Fire Warning System SSP-2A

On An-2 aircraft beginning with 172nd series, an SSP-2A system is installed which performs the following functions:

1) reveals the outbreak of fire in an engine;

2) issues a light signal regarding fire;

3) provides manual control of the fire extinguisher;

4) provides a check of the functioning of the fire-prevention system.

The SSP-2A fire warning system includes: nine DPS-1A sensors (mounted on the engine); a BI-2A actuating unit (located under the floor of the cockpit between frames Nos. 3 and 4); nine R-417 sockets for attaching the sensors to the engine; an AZS-5 automatic circuit breaker of the fire extinguisher (located on the pilots' instrument panel).

The temperature for triggering system at a rate of rise of temperature of the medium surrounding the sensor is equal to 2°C per second, and in the event of simultaneous heating of the three sensors is equal to 170°C. System comes into a state of readiness for action after cessation of the build-up of the temperature of the medium, and also with a decrease in temperature to 130°C (the temperature of release of the system). Ths system also provides no less than five triggerings and return to state of readiness for action under conditions of envelopment of the sensors by flame.

The SSP-2A system preserves its efficiency under the following conditions:

a) with a temperature change of the environment: for the BI-2A actuating unit - within limits of -60 to +60°C; for the DPS-1A sensors - within limits of -60 to +350°C;

b) in the event of brief envelopment of the DPS-1 sensors by flame (on the order of 10 s);

c) with humidity of environment up to 98%;

d) with rarefaction of the atmosphere to 40 mm Hg.

The system does not give false responses during short circuiting and in the event of a break of the circuit of the sensors.

It operates from the aircraft circuit with a voltage of 27 V ± 10%.

The operating principle of the SSP-2A system consists of the following. At the outbreak of fire on the engine the DPS-1A sensors will be enveloped by the atmosphere whose temperature rises not less than 2°C per second. In the thermopiles of these sensors a thermo emf appears causing current in the coil of the winding of the polarized relay in the BI-2A actuating unit sufficient to trigger this relay. The relay triggers and switches on the fire warning light.

When the red fire warning light goes on the pilot must press the button of the fire extinguisher. In so doing power is supplied to the pyrohead of the extinguisher cylinder which is detonated and opens the access for the extinguishing mixture from the cylinder to the spray collector on the engine. In so doing, the yellow SM-31 light goes out signaling the functioning of the pyrohead.

If fire is observed visually, but the warning system for some reason did not trigger, then the button of the fire extinguisher must be pressed without waiting until the red fire warning light goes on.

The functioning of the SSP-2A fire warning system must be checked before flight in the following manner:

1) throw the AZS-5 of the fire extinguisher system. In so doing the yellow warning light for the functioning of the pyrohead of the extinguisher cylinder lights up;

2) throw the switch for checking the functioning of the system into the position of the 1st group of sensors. In so doing, in the BI-2A unit the R_2 relay is tripped and will close

its 2-3 and 5-6 contacts. Thereby the voltage of the aircraft electrical system through the circuits of three DPS-1A sensors will be supplied to the R_1 relay.

The relay trips and switches on the red fire warning light;

3) checking the 2nd and 3rd groups of sensors is produced in the same manner. Only the check switch must be put respectively in the position of the 2nd and 3rd group of sensors. The button of the fire extinguisher in this case cannot be pressed because it triggers the pyrohead of the cylinder.

Electrical System of the Aircraft

The electrical system of the aircraft is carried out mainly by a single-wire circuit with the grounding of the negative wires to the mass of the aircraft.

The following sections of wiring are carried out in a two-wire circuit: the section from the generator to the DMR-400D; the primary winding circuit of the starting coil.

The positive wires which go from the DMR-400D and the storage battery are connected to the positive busbar located on a special textolite panel behind the instrument panel. On the textolite panel, besides the positive busbar, are located the following:

1) RL-70 rheostat, permanently connected into the lighting circuit of the KI-12 compass and used as an auxiliary fixed resistor to reduce the brightness of the illuminating lamp. The knob of the rheostat has been removed;

2) absorbing resistor of 150 ohm of alternating current circuit of the ARK-5 power supply.

3) SP-5 and SP-10 fuses in the alternating current circuit of the ARK-5 and DIK;

4) inertia-safety fuses: IP-150 - in the circuit of the power supply ; IP-50 - in the PO-500 feed circuit; the IP-50 protects the plus wire which goes from the positive busbar to the AZS automatic device on the left panel.

From the positive busbar the plus wires run to the AZS installed on the central hinged board of the instrument panel, on the ANO board, on the central panel, on the left panel, the plus wires of starter and engine ignition.

Connection of the sections of wiring to one another is carried out by means of plugs and demountable blocks. In the center of connection of all the electrical bunch-conductors, between frames Nos. 5 and 6 there is located the central distributing board [TsRShch]. Next to the TsRShch a case of spare lamps is located.

The wiring of the aircraft is carried out with wires of class BPVL (aircraft wire with chlorvinyl insulation in lacquered cotton yarn braid). The BPVL wire consists of a current-conducting conductor, chlorvinyl insulation, and braid. Cross-section of the wires - from 0.5 to 25 mm^2.

Figure 123 shows the pilot's central electrical panel.

For protection against over loading and short-circuiting in the circuits of the electrical system of the aircraft, the following protectors are installed:

. inertia-fuse devices of the IP type, fuses in a sealed glass tube, and AZS automatic circuit breakers;

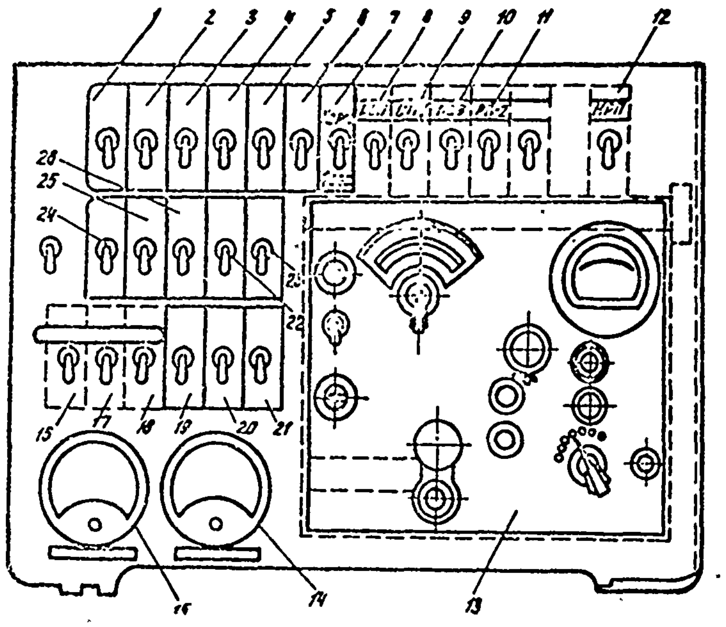


Fig. 123. Pilot's central electrical panel: 1 - AZS-15 upper flaps; 2 - AZS-5 flap control; 3 - AZS-15 lower flaps; 4 - AZS-5 aileron tab; 5 - AZS-5 elevator trim tab; 6 - AZS-5 rudder trim tab; 7 - V-45 switch transmitter mode; 8 - AZS-10 of RSNU-3-M set; 9 - AZS-5 intercom device; 10 - AZS-40 of RSB-5 set; 11 - AZS-5 of RV-2; 12 - V-45 switch of MRP-48 power supply; 13 - radio compass control panel; 14 - A-40 amperemeter; 15 - VA-240 voltampere meter; 16 - V-45 PVD heating switch; 17 - V-45 cabin lighting switch; 18 - V-45 fuselage illumination switch; 19 - AZS-5 of UFO of the right side of left panel, KLSRK-45 left; 20 - AZS-5 of UFO on rod, sockets of portable lights; KLSRK-45 of RSB unit illumination; 21 - AZS-5 illumination under floor, UFO of central control panel, PVD heating; 22 - AZS-5 of siren, illumination behind the door warning panel, dome light in fuselage; 23 - AZS-5 illumination of KN-11 compass, KLSRK-45 right, cockpit dome light, left side UFO; 24 - AZS-10 of oil cooler flaps; 25 - AZS-10 of cowl flaps; 26 - AZS-5 of fire-fighting equipment.

inertia-fuse devices of the IP type are used in circuits with inductive load (motor-alternators, electric motors, etc). The starting current of these units for a few seconds exceeds by several times the rated current consumed by the unit over a prolonged time;

the inertia-fuse device is constructed so that for 10 seconds it is able to withstand a triple overload (the starting current of electric motors) and not burn out.

The basic form of protection of the electrical circuits is the AZS automatic circuit breaker. Each AZS is designed for a specific current, for example, the AZS-5 is designed for 5 A, the AZS-20 - for 20 A, etc. The AZS are made for a current from 2 to 40 A. In the event the current exceeds that for which the AZS is designed, its bimetallic plate bends. The AZS is tripped and opens the circuit. After elimination of the cause for the excess of rated current in the circuit the AZS is manually set in the "on" position.

Aircraft Bonding

The aircraft bonding - this is the joining of all metallic structural parts of the aircraft, units, and its equipment with the aircraft fuselage by metallic conductors of low resistance. Bonding ensures the creation of effective counter-balance for the radio transmitters, reduces radio interference, and increases the fire safety of the aircraft. The joined structural parts of the aircraft behave as one continuous metallic conductor, under action of an electrical charge on which all the bonded elements will have one potential.

The following elements on the aircraft have been bonded: the controls of aircraft, engine, engine frame, fuel and oil system, instrument panel, electric and radio equipment (conductors and apparatus). The bonding of detachable and movable units and assemblies is carried out by flexible bonds of metallic braid whose leads are sealed into tubular terminals.

For compensation of potentials of the aircraft relative to the potential of the earth, on the fork of the tail wheel a steel cable is fastened whose length makes it possible to connect the aircraft with the ground when parked or during travel along the ground.

The content of bonding and screening of the aircraft in operative condition ensures reliable radio communication and the fire safety of the aircraft, therefore during servicing it is necessary to check:

the soundness of all bonding connections;

the presence of lock washers on the screws which attach the bonding connections;

the tightness of the screws holding the bonding connections;

for oxidation in the joints of bonding connections between the aircraft fuselage and the parts being bonded;

the reliability of the tightening of the spark plugs in the cylinders of the engine;

the tightness of all couplings in screening and grounding of the high and low voltage wires.

§ 35. RADIO EQUIPMENT OF An-2 AIRCRAFT

The radio equipment of the An-2 aircraft includes the following:

1) communications radio set RSB-5;

2) command ultrashort wave radio set RSIU-3M, or R-360;

3) automatic radio compass ARK-5;

4) low altitude radio altimeter RV-2;

5) marker receiver MRP-56P;

6) aircraft intercom SPU-5 or SPU-6.

Radio Set RSB-5

The RSB-5 radio set is intended for simplex telephone-telegraph communication with ground-based radio stations and also for communication between aircraft in the air and is a short-wave receiver-transmitter.

The complete RSB-5 set includes:

1) two high frequency units;

2) a common stand for the unit;

3) power element with an RUK-300B converter;

4) antenna element with a quartz calibrator;

5) control panel combined with a telegraph key;

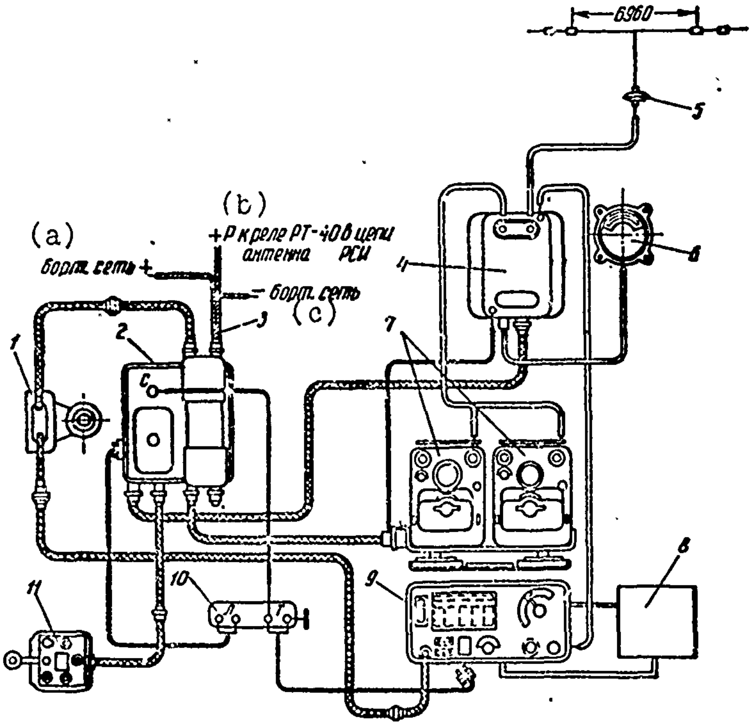
6) US-P (or US-9DM) receiver;

7) interphone headset;

8) remote indicator;

9) rigid antenna and junction cables.

Figure 124 depicts a semi-assembled diagram of the RSB-5 radio set.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(b)
+Р к реле РТ-40 в цепи антенна РСИ
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11

Fig. 124. Semi-assembled diagram of RSB-5 radio set: 1 - converter RU-11AM; 2 - power element; 3 - power supply cable; 4 - antenna element; 5 - partition insulator; 6 - remote indicator; 7 - high frequency units; 8 - US-9DM control panel; 9 - US-9DM receiver; 10 - subscriber block; 11 - control panel.

KEY; (a) Aircraft circuit +; (b) +R to relay RT-40 in antenna circuit; (c) -Aircraft circuit.

Two high frequency units of the radio set together with the support units are installed on frame No. 5 on the cargo compartment side to the right of the door. The power element of the radio set is placed in a recess in the cargo floor at frame No. 5. The antenna element is mounted on duralumin angle irons fixed to the right-side stringers between frames Nos. 5 and 6.

The control panel of the radio set is installed in the cockpit on the right side. The remote indicator instrument is attached near the high frequency units. The US-P receiver is located in a niche in the instrument panel of the right pilot. The antenna of the radio set is stretched between the mast and the tail fairing of the aircraft.

The frequency range of the RSB-5 radio station - 2.15-12 MHz (from 140 to 25 m). The distribution of the overlapping frequencies of the band between units and the calibration of the frequencies of the unit are given in Table 13.

Table 13.

Units	I sub-band (amplification) with graduated frequencies	II sub-band (doubling) with graduated frequencies
BP-2	From 2.15 to 3.6 MHz through 10 kHz	From 4.3 to 7.2 MHz through 20 kHz
BP-3	From 3.6 to 6 MHz through 20 kHz	From 7.2 to 12 MHz through 40 kHz

The output from the transmitter to the antenna, depending on operating frequency and the length of the antenna, in telegraphic mode can comprise from 35 W a lowest frequencies of the band up to 120 W - at the highest frequencies. In voice mode, the power of the transmitter comprises 20-50% of the telegraphic. The transmitter can operate in telegraphic and voice modes at reduced power equal to 25% of total.

The range of the RSB-5 during operation in the modes: telegraphic - not less than 400 km; voice - not less than 200 km.

The two units of the radio set on the ground can be tuned to two different waves. In flight, with the help of the control panel, it is possible to select either of these waves for operating.

The power source of the radio set is the aircraft circuit with a rated voltage of 27 V. Power consumed from the circuit - 800 W.

In the transmitter a quartz-crystal frequency control is provided.

The percentage modulation of the transmitter can be regulated by a switch on the power element having three positions. The normal position is the second one.

The transmitter is capable of operation with fluctuations of ambient temperature from +50 to -60°C and relative atmospheric humidity up to 98%, and in the presence of aircraft vibration.

The transmitter permits continuous working for 30 min when first switched on and continuous working on a cycle: 5 min - work, 10 min - break.

There is full control of the radio sets in flight: transition from receiving to transmitting, from telegraph to voice, from full power to reduced, changing of wavelengths is performed remotely from the control panel. The control panel is structurally combined with the telegraph key.

The transmitter has control of its telegraph and voice working on high frequency independently of the tuning of the receiver. The weight of the radio set - 38 kg. For protection against short circuits, in the radio set there are AZS-40 and fuses. The AZS is installed on central hinged board and it serves simultaneously as the "on" switch and the "off" switch of the radio set. Two 10 A fuses are installed on the power supply circuits of the radio set in the low voltage circuits. Two 0.5 A fuses are installed in the high voltage circuits (+1000 V and +350 V). All the fuses are in the power element.

Block Diagram of the Transmitter

A block diagram of the transmitter is shown in Fig. 125. Each of the high frequency units is an independent three-stage transmitter.

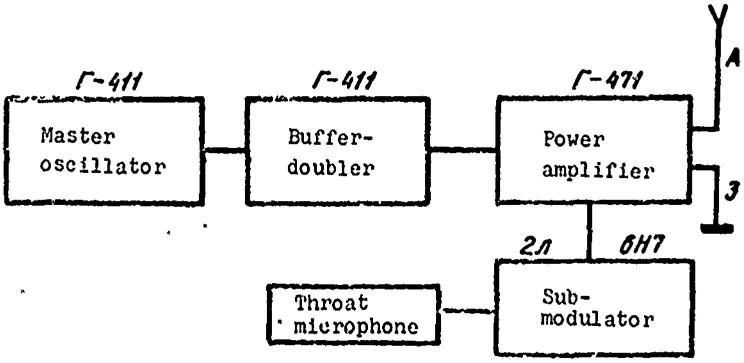

Fig. 125. Block diagram of transmitter

The master oscillator mounted on a G-411 tube, serves for the excitation of continuous high frequency oscillations.

The buffer-doubler mounted on a G-411 tube, amplifies or doubles these oscillations. But its basic function is to remove the harmful effects of the power amplifier on the master oscillator.

The power amplifier mounted on a G-471 (GK-71) tube serves for amplification of the high-frequency oscillations according to power. Besides three stages, in the high frequency unit there is also the rectifier of the tuning meter of the output stage.

In the power element of the radio set two 6N7 tubes are installed. One of them is a two-stage amplifier (modulator) for amplifying the voice frequency which enters from the throat microphones, the other - the audio frequency oscillator with a rectifier to get negative bias on the grid of the G-411 tubes.

In the transmitting part of the radio set use is made of the following types of radio tubes:

1) in each high frequency unit: G-411 - 2, G-471 - 1, 6A7 - 1;

2) in the power element: 6N7 - 2;

3) in the antenna element: 6A7 - 4, 6N7 - 1.

Figure 126 shows the front panel of the high frequency unit. Both HF units are made structurally identical. On the front panel of the HF unit are all the controls for tuning and monitoring the working of the unit. On the base of the unit there are located a "T" board for connection of the headsets in tuning, the lower capacitance terminals, a board for connection of the cable to the power element and an "I" terminal for connection of the antenna element.

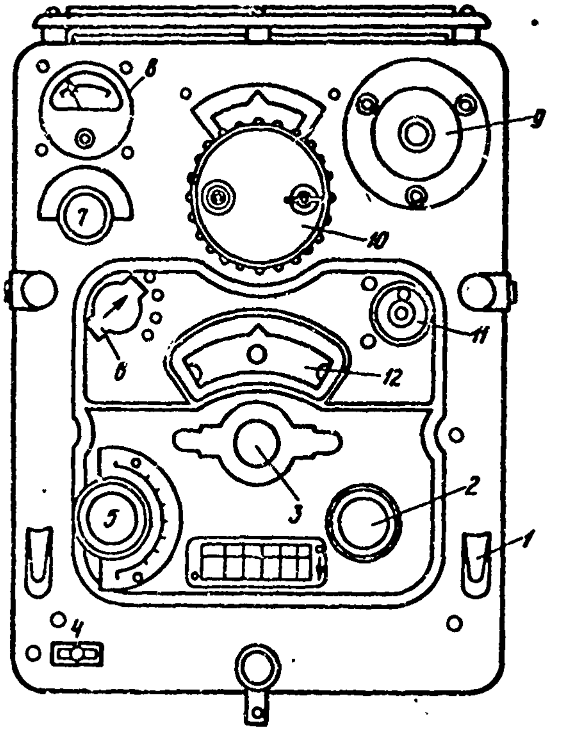

Fig. 126. Front panel of the high frequency unit: 1 - bracket for removal of the unit from the base; 2 - "Frequency" knob for setting the assigned frequency; 3 - band selector; 4 - non-locking key for connection of the unit; 5 - "Fine tuning" knob; 6 - "Coarse tuning" switch; 7 - instrument switch; 8 - check meter; 9 - Boole terminal for connection of the unit to the antenna element; 10 - antenna tuning knob; 11 - "Parallel-Series" ["PR-PS"] ("ПР-ПС") switch; 12 - tuning dial.

Operation of the Radio Set

Operation of radio set reduces to the tuning of the radio set, control in flight, systematic maintenance of it, and to elimination of the simplest malfunctions in flight.

The radio set is tuned directly from the front panel of the unit. Before switching on the radio set it is necessary:

1. To set all switches on the control panel "out," i.e., the "Receive-Send" ["PRM-PRD"] ("ПРМ-ПРД") into the "PRM" position, the "Morse-Voice" ["TLG-TLF"] (ТЛГ-ТЛФ") into "TLF" position. The position of the "25-100%" switch - is immaterial. The wave switch - in position 1 or 2.

2. To switch on the radio set with the automatic circuit breaker with the inscription "RSB" on the central panel of the instrument panel.

3. To determine the high frequency unit in the range of which the assigned frequency is found (by the inscriptions on label around the wave-changing switch of the unit).

4. To set the "Current checking" switch of the unit to the "EIII" positions.

5. To unlock the tuning knob of the unit.

6. To set the wave-changing knob of the unit in the necessary position (to push in or pull out the knob). When the frequency switch is pressed it doubles and therefore, the value of the scale divisions changes twofold.

7. To set the "Frequency" knob on the scale to the assigned frequency on the hairline mark.

8. From the tuning direction tables which belong to the radio set, to determine the position of the "PR-PS" switch, the "Antenna tuning" knob, the "Coarse tuning," "Fine tuning" knobs, and to set them in the positions indicated.

9. To switch on the unit by pressing as far as it will go to the left the head of the non-locking key on the front panel (position "N").

10. With the "Antenna tuning" knob, turning it to the left or to the right for several turns from the position established in the table, to tune the output circuit to maximum deflection on the remote indicator instrument connected with the antenna element.

11. To press the non-locking key to the right as far as it will go and with the "Fine tuning" and the "Antenna tuning" knobs turning them in turn not more than 1/5 of a turn to the left

or to the right, to attain such a position, that the readings of the antenna amperemeter will be maximum, and so that the needle of the instrument on the front panel of the unit is in the green sector. This will correspond to the optimum mode of operation of the transmitter.

Since the tuning of the units is conducted at the right position of the key on the front panel, i.e., under voltage on the protective grid of the tube of the output stage of +26 V, then during subsequent telegraphic working, the needle of instrument will be somewhat more to the left of the sector or on its left limit. When working in telephone mode, the needle of the instrument will be more to the right of the sector or on its right limit.

If the needle of the instrument with the key in the right position goes beyond the limits of the sector it is necessary to proceed as follows:

1st case. Working with a series output circuit. Switch in the "PS" position. When the needle does not reach the green sector (a condition of undervoltage), it is necessary to increase the connection of the tube with the circuit, for which:

a) turn to the right not more than 1/5 of a turn the "Antenna tuning" knob (to increase self-induction);

b) with the "Fine tuning" knob tune the readings of the check meter to the maximum;

c) repeat operations "a," "b" until when tuning to maximum current the needle of the check meter stops in the middle of the sector of the scale.

When the needle passes the green sector of the scale (the over-voltage condition), it is necessary to perform operations "a," "b," and "c," changing to counter rotation of the knob, i.e., to decrease the connection of tube with the circuit, decreasing self-induction and increasing capacitance;

d) in cases when the "Fine tuning" reaches the stop in one of the extreme positions (0 - minimum capacitance, or 110° - maximum capacitance) but the normal position of the needle is not obtained and further change in connection is necessary, it is necessary to change the position of the "Coarse tuning" knob to a lower number (decrease in capacitance) as the "Fine tuning" knob approaches 0, or to a larger number (an increase in capacitance) on approach to 110°. In so doing, the position of the "Fine tuning" knob corresponding to tuning to the maximum of current will change and will pass with the decrease in the number of the "Coarse tuning" position in the direction of an increase in degrees, and with an increase in the "Coarse tuning" number - in the direction of a decrease in degrees.

Switching the "Coarse tuning" knob and shifting from one scale to the other with the "Fine tuning" knob can be performed only with the unit turned off. Switching the "Coarse tuning" knob and tuning the circuit to a new position with the "Fine tuning" knob can be performed only after transfer the key to the "N" position (to the left).

After tuning the circuit the key must again be transferred to the right position and the circuit aligned in normal mode in accordance with operations "a," "b," "c."

In all cases of operation it is not possible to obtain a "correct" position of the needle of the check meter because of imprecise tuning of the "Fine tuning" knob. This knob must always be set in the position closely corresponding to maximum deflections of both the indicator and the check meter.

In aligning the output circuit to normal mode with the position of the key on the right, it is not permissible to make significant misalignments of the circuit with the "Antenna tuning" knob and the "Fine tuning" knob, much less to switch the "Coarse tuning" because this can lead to putting the tubes of the output stage out of commission.

2nd case. Working with a parallel output circuit. The switch in the "PR" position. With a parallel output circuit the "Fine tuning" variable capacitor is switched from the anode of the output stage tube over to the "B" terminal of the unit, i.e., parallel to the antenna of aircraft while the "Coarse tuning" capacitors remain connected to the anode. Because of this, tuning with a parallel circuit differs from tuning in a series circuit in that the rotation of the knobs in performing operations "a," "b," "c" and "d" has a counter direction, i.e., when in cases with the needle of the check meter does not reach the middle of the sector (undervoltage condition), the "Antenna tuning" knob is turned to the left, the "Fine tuning" knob - to the right, and when the needle passes over the middle of the sector, the "Antenna tuning" knob is turned to the right, and the "Fine tuning" knob - to the left. The sequence of changing the "Coarse tuning" also changes, i.e., as the "Fine tuning" knob approaches 0, the position of the "Coarse tuning" must be increased in number, and on approaching 110° - be reduced.

In tuning the output circuit during working with both series and parallel output circuits it is necessary to bear in mind that, as a result of the presence of wide possibilities of variation in the capacitance and self-induction of the output circuit, cases can take place of tuning the circuit to the harmonics of the assigned frequency, i.e., doubling or even tripling the frequency in the output stage. Therefore, it is necessary to pay attention that the position of the "Coarse "tuning," "Fine tuning" and "Antenna tuning" knobs correspond to the tentative positions indicated in the tables, or deviate insignificantly from them.

Tuning the radio set to antennas not indicated in the tables. In doubtful cases, and also in the case of tuning to an antenna not indicated in the tables, the tuning of the output circuit must be performed in the following sequence:

a) set the switch to the "PS" position (series circuit) and the "Coarse tuning" knob - to the position "1," the "Fine tuning" knob - position "25," and the "Antenna tuning" knob is rotated to the right to the stop (i.e., set at maximum self-induction);

b) after switching on the unit (the key in the "N" position) rotating the "Antenna tuning" knob to the left, find the first maximum deflection of the needle of the indicator instrument. This position will correspond to tuning the output circuit to the assigned frequency. Further tuning to normal mode should be performed as shown above.

In the absence of tuning or in the event of impossibility of obtaining the normal position of the needle of check meter, it is necessary to go over to the parallel circuit, i.e., to set the switch in the "PR" position and the knob - in the positions indicated in operation "a," and to complete tuning by the method indicated above.

It must be remembered that working on a parallel circuit is less advantageous and can take place only for long antennas in the short-wave section of the antenna. For instance, for an antenna in 9.5 m, the parallel circuit should be used with frequencies above 7.5 MHz.

The knob positions obtained after tuning to the optimum mode should be entered in the tables for the purpose of accumulating data and facilitating subsequent tunings at this frequency.

After tuning the radio set, switch off the unit and carefully lock the knobs.

The second unit is tuned in similar fashion.

All switchings on the control panel can be executed only in the "Receive" position because otherwise it is possible to burn-out the fuses in the high voltage circuit and to burn the contacts of the antenna relay and the relay of the units.

During operation it is necessary to watch the readings of the antenna amperemeter and to check its operation.

The simplest malfunctions of the RSB-5 transmitter and means of their elimination are given in Table 14.

Table 14.

Malfunction	Cause of malfunction	Means of elimination
Apparent malfunctions in tuning		
Transmitter is not tuned: there is no current in antenna	1. Switch on the control panel is in the "Telegraph" position	Set the switch to the "Telephone" position
	2. Quartz calibrator not switched off	Set switch on antenna element "Switched off"

Table 14 (Cont'd.).

Malfunction	Cause of malfunction	Means of elimination
	3. With two high frequency units the "Wave" switch on the panel stands in position "3"	Set the switch to position "1" or "2"

Malfunctions of the transmitting part of the radio set

When transmitter is switched on the RUK-300B converter does not start	1. Burnt-out 10 A fuse in the power element	Replace fuse
	2. No contact in the plug connecting the high frequency unit with power element	Tighten the ring of the plug connecting the cable from the power element to the base of the high frequency units
	3. Burnt-out channel filament in the GK-71 (G-471) tube in the high frequency unit	l place tube in inoperative unit
In tuning each high frequency unit there is no output in antenna	1. Burnt-out 0.5 A fuse in the +350 A circuit, which can be determined from the absence of currents in A-1 and A-2 instruments	Replace fuse in power element
	2. Burnt-out 0.5 A fuse in +1000 V circuit, which can be determined by the off-scale reading of instrument in position E-III	Replace fuse
	3. One of the 6A7 tubes in the antenna element is out of order	Replace all 6A7 tubes in antenna element, taking them from the spare kit

Table 14 (Cont'd.).

Malfunctions	Cause of malfunction	Means of elimination
	4. No contact in the plug of the cable from power element to high frequency units	Tighten the fastening ring of the plug of connecting cable
	5. Break in the conductor that connects "I" terminals with base of high frequency units	Replace conductor with new one
There is no reception in its operation	1. Defective 6A7 or 6N7 tubes in antenna element	Replace defective tubes
	2. Burnt-out filament in one of the 6A7 tubes in power element	The same
Transmitter is not tuned, no output in antenna	1. Defective G-411 tube in master oscillator, which can be judged by absence of A-1 current	Replace tube
	2. Defective G-411 tube in buffer-doubler, which can be judged by absence of A-2 current	The same
	3. Defective GK-71 (G-471) tube which can be judged by absence of E-III current	"

Note. Before removing the tubes of transmitter it is necessary to release their holder to avoid separating the bulb of the tubes from the base.

Care of the RSB-5 Radio Set

In order for the radio set to operate reliably it is necessary:

1. To keep the radio set clean and regularly, especially during flight, to clean dust from it. When not operating, all working elements of the radio set should be covered with waterproof covers. It must be remembered that dirt and moisture impair insulation.

2. To keep all contacts of the radio set clean and in order. Contacts of the relay, key, connecting wires, and blocks should be cleaned of corrosion, carbon deposit, and dust.

3. To check on the functioning and the cleanness of the antenna system, the cleanness of the partition insulators as well as the reliability of contact in wiring points of the antenna and balancing capacitance.

4. To check on the cleanness of the commutators of the RUK-300B and RU-11AM converters, and the functioning of the brushes and brush holders. See to it that brush dust does not accumulate in the converters and that moisture does not get into them.

5. To check on the functioning of the cushioning and the cross connections of the bonding of the radio set.

6. To keep the earphones and throat microphones in constant good condition, to store them in a dry place because moisture impairs the working of the headsets and throat microphones. To protect the headsets and throat microphones from shocks, and their cords - from breaks.

Radio Receiver US-9DM

The all-purpose aircraft remote-controlled radio receiver US-9DM (improved) serves for radio-telephone and radiotelegraph communication between the aircraft and the ground. On the An-2 aircraft it operates as a unit with the RSB-5 transmitter.

The US-9DM radio receiver is an 11-tube superheterodyne. It has automatic and manual sensitivity controls and a quartz filter for narrowing the band width during reception under conditions of interference.

The US-9DM set (Fig. 127) consists of the receiver proper, a remote control panel and connecting cables. The receiver is installed to the right at frame No. 5, the panel - in a niche of the right pilot's instrument panel.

The wave band of the US-9DM radio receiver is 200-500 kHz and 1.5-1.8 MHz. The entire band is broken into 6 sub-bands. The calibration of the receiver is marked on the scale of the remote control panel. The error in calibration is not more ±1-2%.

The sensitivity of the receiver under low frequency voltage on input of 15 V comprises:

in telegraphic mode - not lower than 6 μV;
in voice mode - not lower than 15 μV.

The intermediate frequency of the receiver is 915 ± 1 kHz.

The radio receiver has a tone correction of telegraphic signals within limits of ±4000 Hz.

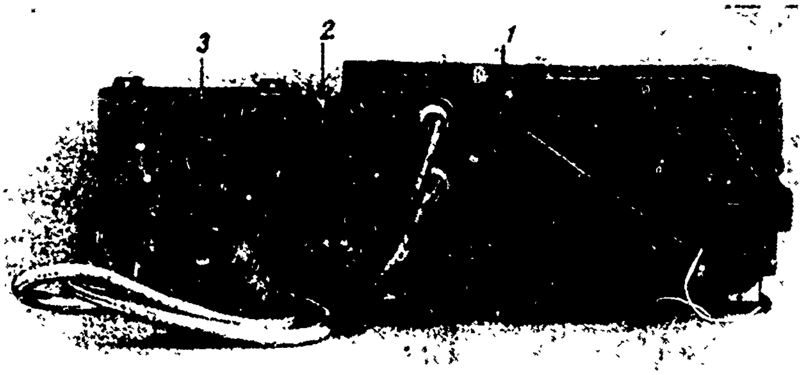

Fig. 127. General view of a radio receiver set of US-9DM type: 1 - radio receiver; 2 - connecting cables; 3 - control panel.

The receiver normally operates at an ambient temperature of from -60 to +50°C and relative humidity up to 98%.

The following tubes are used in the receiver:

6K7 - high-frequency amplifier [UVCh] (УВЧ);

6K7 - second high-frequency amplifier (UVCh);

6Zh7 - mixer tube;

6S5 - first heterodyne;

6K7 - IF amplifier [UPCh] (УПЧ);

6F7 - second UPCh and second heterodyne;

6B8S - third UPCh, detector, and automatic sensitivity control detector [ARCh] (АРЧ);

6P6S - low frequency amplifier [UNCh] (УНЧ);

6Zh3P - frequency control stage of the second heterodyne;

SG2S - voltage stabilizer;

SM-31 - lamp for illumination of the dial and the alternating current power supply connection indicator.

For the receiver power supply the required voltage is: direct current of 27 V from the aircraft electrical wiring system and alternating current of 115 V 400 Hz (from the PO-500 converter).

Power consumed from the electric power sources:

on direct current - 75 W;
on alternating current - 60 VA.

High voltage on the anodes of the tubes of receiver is supplied from a U-18-2 converter located inside the receiver housing.

Control of receiver is remote. On the front of the control panel, the following controls of the receiver are located:

band switch;

receiver tuning knob;

receiver dial with illuminating lamp;

main switch with three positions: "ARCh" - "OFF" ["VYKL"] ("ВЫКЛ") - "Manual Sensitivity Regulator" ["RRCh"] ("РРЧ");

"TLG-TLF" switch;

quartz filter switch;

volume control;

dial illumination control;

beat note regulator knob;

antenna alignment knob;

two plug sockets for the headset connection;

"ON" warning light - 115 V.

Weight of the radio receiver set - 24 kg.

For protection of the circuits of the US-9DM receiver the following fuses are used:

10 A - in the power element of the RSB-5 in the d-c circuit;

5 A - in the right upper corner of the housing of the receiver in the d-c circuit;

2 A - in the "RK-115 V" in the a-c circuit.

Operation of the Receiver

1. Switching on and tuning. Check the correctness of connection of the power supply cables, the antenna wires and grounding, the cables connecting the control panel with receiver.

The switch on the subscriber set of the SPU is set in the position "Communications radio set." Switch on the 28.5 V power supply by means of the AZS-40 on the electrical panel of the instrument panel with the inscription "RSB"; switch on the PO-500 converter. In so doing the lighting of the "115 V" light will show that a-c voltage is given to the remote control circuit of the receiver. Set the knob of the fine adjustment of the beat note with the needle vertically upward.

Coordinate the tuning dial of the control panel with the unit of variable capacitors of the receiver. To do this, it is necessary to rotate the "Tuning" knob first to the right to the stop and then back - to the left to the stop.

Upon conclusion of the coordination the "Tuning" knob on the control panel should be locked and the lever of the knob turned 20° from its on-position. If the knob is not locked, then in case of its accidental rotation or spontaneous turning during shaking, in the case of disconnection of the 115 V voltage with frequency of 400 Hz, there will occur mismatching between the tuning dial and the unit of variable capacitors, which will cause nonconformity of the calibration of the dial to the tuning frequency of the receiver.

Set the knob of the main switch to the "RRCh" position, in so doing, the supply of 27 V direct current will be given to the channel filament of the tubes and the converter of the receiver.

By turning the knob of the dial illumination control, set the desired illumination. The lighting up of the dial illumination light and the low hum of the converter will show that voltage of 27 V is being given to the receiver.

Rotate the "Volume" knob clockwise. If thirty seconds have elapsed since the moment of switching on the receiver (the time required for warming up the filaments of the tubes), then in the headsets there will be heard a noise which is amplified in proportion to the rotation of this knob. Stopping at the average volume of this noise, proceed to tune the receiver to the correspondent and to receive his transmission.

2. Reception of telephone transmission or voice-frequency carrier telegraphy. Set the "TLG-TLF" switch to the "TLF" position and with the help of the sub-band switch set the necessary sub-band of frequencies. Rotating the "Tuning" knob, set on the scale the necessary frequency, and slowly changing the tuning around this frequency, accurately tune to the correspondent.

With the "Antenna alignment" push-button switches the greatest volume of received signal is achieved. If the signal strength changes sharply, then it is necessary to go over to automatic sensitivity control, for which set the main switch to the "ARCh" position and set the "Volume" again to the desired sound strength in the telephone.

It is recommended that searches for a correspondent be made only with the manual sensitivity control ("RRCh").

In the event of heavy interference from other radio stations it is necessary to switch on the quartz crystal. However, when receiving very weak telegraphic signals the connection of the quartz crystal may even make the quality of reception worse.

At the termination of work it is necessary to disconnect the receiver, which is done by setting the main switch in the position "Off," and also to disconnect the RSB-5 and the PO-500 converter.

3. Reception of telegraphic continuous-wave transmission. In this case the sequence of work remains similar to that indicated

above, with the exception that the "TLF-TLG" switch must be set in the "TLG" position. Tuning to the frequency of the correspondent is performed, and the "Beat note" knob is used to set the signal tone.

In the event of powerful interference from adjacent stations, for an increase in selectivity of the receiver, it is necessary to connect the quartz filter. In so doing, it is necessary to bear in mind that because of narrowing of the band width, a more precise fine adjustment of the receiver to the correspondent and more careful volume control and beat note will be required.

Shift over to automatic sensitivity control is made by setting the main switch to the position "ARCh." In so doing level of the volume is adjusted by the "Volume" knob.

Checking of the receiver is accomplished in the following manner:

1) the antenna, "Ground" wire, and connecting cables are inspected;

2) a check is made of the functioning of the shock absorbers, the fastenings of the receiver and the control panel;

3) the functioning of all controls of the receiver are checked;

4) by receiving external radio sets a check is made of the working of the receiver at several points of the band in telephone and telegraphic modes;

5) the presence and completeness of spare equipment (spare tubes, fuses) are verified.

Radio Set RSIU-3M

The RSIU-3M radio set (Fig. 128a) is a receiving-transmitting, ultrashort-wave, radio-telephone set intended to provide communication between the aircraft and the ground in air traffic control [ADS] (АДС) and area traffic control [RDS] (РДС) zones, and also for communication between aircraft.

The complete radio set includes:

1) transmitter - "A" unit with shock-absorbing frame;

2) receiver - "B" unit with shock-absorbing frame;

3) selenium rectifier - "C" unit with shock-absorbing frame;

4) remote control panel - the "P" unit;

5) antenna;

6) cable assembly;

7) set of quartz crystals;

8) PO-500 converter.

The transmitter and receiver of the radio set are installed on frame No. 5 on the cargo section side, above the high frequency units of the RSB-5 radio set. The selenium rectifier is located above the entrance door to the cockpit. The remote control panel is located on the central control console in the cockpit. The broad-band rod antenna of the radio set is fastened to the upper skin of the aircraft between frames Nos. 15 and 16. By means of the antenna feeder the antenna is connected with the radio set.

The PO-500 converter is located under the floor of the cockpit.

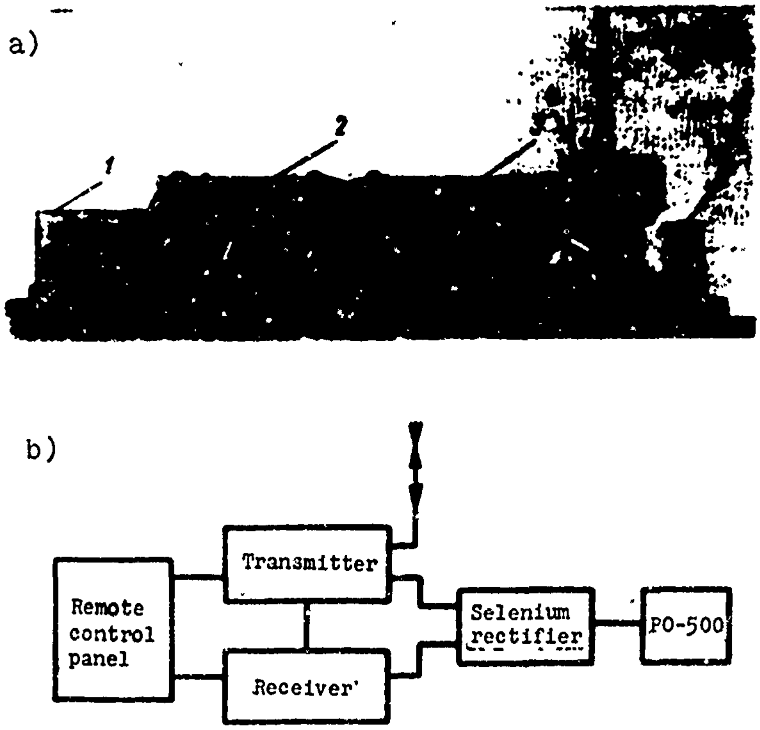
a)
1
2
b)
Transmitter
Remote control panel
Selenium rectifier
PO-500
Receiver

Fig. 128. Radio set RSIU-3M: a) general view of the radio set: 1 - selenium rectifier; 2 - receiver; 3 - transmitter; 4 - PO-500 converter; 5 - rigid antenna; 6 - control panel; b) block diagram of the radio set RSIU-3M.

The wave band of the RSIU-3M radio set is 100-150 MHz (2-3 m) with quartz-crystal stabilization of the frequencies of the transmitter and receiver ensuring "no-hunt" and no-fine-tuning communication during operation of the radio set on the aircraft.

The range of action of the radio set, depending on flight altitude, is given in Table 15.

Table 15.

Flight altitude, m	1000	2000	5000	10 000
Range of action, km .	120	160	230	350

During operation between aircraft flying at an altitude of 500 m the range of the radio set is 120 km.

Control of the radio set is remote and is accomplished from the control panel installed in the cockpit. The radio set can be preset to any of four band frequencies and any of these frequencies can be used for communication. The tuning frequencies of transmitter and receiver can be different.

The radio set is ready for operation 1-2 min after it is switched on. The time of transition from wave to wave is not more than 3 s. Transition from receiving to transmitting is accomplished by pressing a button on the control column.

The power consumed by the radio set from the aircraft system of a-c current with voltage of 27 V:

during transmission - 415 W;
during reception - 270 W.

Figure 128b depicts a block diagram of the RSIU-3M radio set.

The transmitter is designed in the form of a separate unit. The frequency range of the transmitter - 100-150 MHz with quartz-crystal frequency stabilization. In the transmitter there are the following tubes: 6P6S - 4, GU-32 - 2, 6Zh3P - 1, 6G2 - 1. Radiated power of the transmitter is 6 W. Amplitude modulation is anode-grid.

The transmitter ensures prolonged working in a cycle: 1 min - transmission, 2 min - reception and continuous service when first switched on for 15 min. Control of the transmitter - remote.

The receiver is designed in the form of a separate unit. The receiver is a 13-tube superheterodyne with a dual frequency converter.

The band of the receiver - 100-150 MHz with quartz-crystal frequency stabilization. The sensitivity of receiver is not less than 12 μV. The band width - 100 kHz.

The tubes of the receiver: 6Zh3P - 5, 6K4 - 3, 6G2 - 3, 6P6S - 1, 6Kh6S - 1.

The receiver has automatic amplification control maintaining a constant level of volume.

In order to eliminate operator fatigue from the constant super hum in the receiver there is a special noise suppressor, automatically turning off the receiver when the carrier frequency of the correspondent's signal is not present. The noise suppressor is connected on the front panel of the receiver under a detachable housing. The receiver is rated for prolonged, continuous service. Control of the receiver - remote.

The selenium rectifier serves for rectification of the alternating current supplied from the PO-500 converter.

Obtained voltages:

a) for supply of anodes of the tubes in the "Transmission" mode +310 V, in the "Reception" mode +275 V;

b) for power supply of the bias circuits in the "Transmission" - 120 V, in "Reception" mode - 105 V.

Power supply for the tube filament comes directly from the aircraft system with voltage of 27 V after suppressing excess voltage on the resistances in the transmitter and receiver.

On the front panel of the "B" unit there is a 1 A fuse.

The remote control panel of the radio set is carried out in the form of a separate unit and is located in the cockpit. It is intended for control of the radio set and selection of the necessary communications channel.

On panel there are located four channel knobs, the volume control knob, a "1-2" switch (under a clamp) and the channel trip-out knob.

The antenna of the UKV-radio set is a quarter-wave, broadband dipole connected by means of an antenna relay placed in the transmitter, either to the transmitter (during transmission), or to the receiver (during reception). The "Receive-Transmit" knob is placed on the pilot's control column.

The RSIU-3M radio set is tuned to four waves on the ground by the radio mechanic with the help of the special "I" unit - the display and tuning unit which connects in turn to the transmitter and receiver in tuning. The complete tuning of the radio set is performed by the two tuning knobs of the receiver and by the three tuning knobs of the transmitter.

All control of the radio set in flight and on the ground is reduced to switching on with the switch with the inscription "RSI" on the pilot's electrical panel, to selection of the necessary communication channel, and to selection of the necessary volume.

Transition from reception to transmission is accomplished by pressing the button on the control column.

The radio set provides reliable communication in flight at the guaranteed ranges and requires in this case no additional fine adjustment and regulating.

Transition from one wave to another is accomplished automatically by pulse-motors. For this, it is sufficient only to press the channel knob on the control panel.

During operation it is necessary to check:

1) the correctness of connections and the fastening of the units of the radio set;

2) the presence of grounding of cables and the connection of the airplane fuselage to the corresponding terminals on the units and the shock-absorbing frames;

3) the firmness of seating of all plugs in panels. To close all housing covers with the appropriate locks;

4) the work of the radio set on the ground while the engine is running for communication with the takeoff radio station on the necessary working channels, whereupon the radio set is ready for flight.

It is forbidden:

1) to forcefully rotate the fixed knobs or lever mechanism in switching channels because in so doing it is possible to damage the lever mechanism;

2) to switch the radio set into the aircraft system with voltage below 24.3 V and above 29.7 V and into a network not having a storage battery in the buffer. Failure to observe

this rule can mean possible failure of the motor-alternator, the automatic device and the tubes. It must be remembered that undervoltage is just as dangerous for the radio set as increased voltage;

3) in changing the tubes not to place them in their own places. This can involve failure of the receiver.

In other respects, all the rules for care of the RSIU-3M radio set are the same as for the RSB-5 radio set.

In flight it is possible to replace a burned out fuse in the RK-115 and in selenium rectifier in the absence of transmission and reception. The remaining malfunctions of the radio set are eliminated by technicians of the Radio-Electrical Equipment and Communications Station [RESOS] (РЭСОС) on the ground. Breaking the seals on equipment in flight is not recommended.

Automatic Radio Compass ARK-5

The ARK-5 radio compass is an aircraft radio direction finder, on the course indicator of which the radio set course angle [KUR] (КУР) is automatically set.

Basic specifications of the ARK-5 radio compass.

1. Range band of the radio compass - 150-1300 kHz (2000-230 m).

2. Sensitivity: during reception on opened antenna - 5-10 μV, during reception on the frame - 30-50 μV.

3. Range of action of the apparatus as an automatic compass depends upon the power of the radio station being received and the wave length:

when working with a homing beacon station - 150-300 km;

with a medium-power radio broadcasting station [ShVRS] (ШБРС) - 400-500 km;

with a high-power ShVRS - 1000 km.

The longer the waves of the radio station on which the bearing is taken the greater the range of action and the more precise the direction-finding.

4. Compass sensitivity[1] - not less than 2°.

5. Power supply of the ARK-5 on some circuits (the relay, the band switching motor and others) is accomplished directly from the aircraft system. Under an aircraft system voltage of 27 V, the current in these circuits is 0.3-0.7-3.5 A. The main ARK-5 circuits are supplied with alternating voltage of 115 V with a frequency of 400 Hz developed by the PO-500 converter. The overall power consumed by the radio compass from the aircraft system comprises about 600 W.

6. The weight of the ARK-5 assembly - 32 kg.

7. The ARK-5 makes it possible to take bearings to within 1°, but in taking a bearing on a radio station considerable errors can be introduced the causes for which are:

imprecise maintenance of course of the aircraft at the moment of taking the bearing;

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[1] Compass sensitivity is the minimum angle of deflection of the loop from the position of null reception, at which the automatic rotation circuit of the loop is triggered and the loop rotates to the null reception position.

inaccuracy in the deviation charts of the magnetic compasses;

inaccurate tuning to the radio station on which the bearing is taken;

the presence of night, mountain, and shore effects.

The accuracy of direction-finding is considerably affected by the so-called "night effect" whose action is particularly expressed in the evening (the period beginning 1 hour prior to sunset and ending 2 hours after sunset) and in the morning (beginning - 2 hours before sunrise and ending - 1 hour after sunrise). Night effect can give an error of 8-10°.

8. Control of the radio compass - remote, from the panel.

ARK-5 Unit and Its Installation on the Aircraft

The ARK-5 unit consists of the following elements: radio receiver, remote control panel, open antenna, loop antenna, PO-500 converter, two course indicators, the pilot's SUP and the navigator's SUSh, the loop dehydrator, and the connecting cables. Figure 129 shows a semi-mounted diagram of the ARK-5.

The arrangement of the components of the radio compass on the An-2 aircraft has several versions. On aircraft of the first series, the radio compass receiver was installed in a box bracket attached by bolts and anchor screw nuts to the elements of the structure of the fuselage on the left side between frames Nos. 5 and 6.

On aircraft of the latest series, the receiver is installed from above under the skin of the aircraft between frames Nos. 6 and 7 and is enclosed by a readily detachable housing.

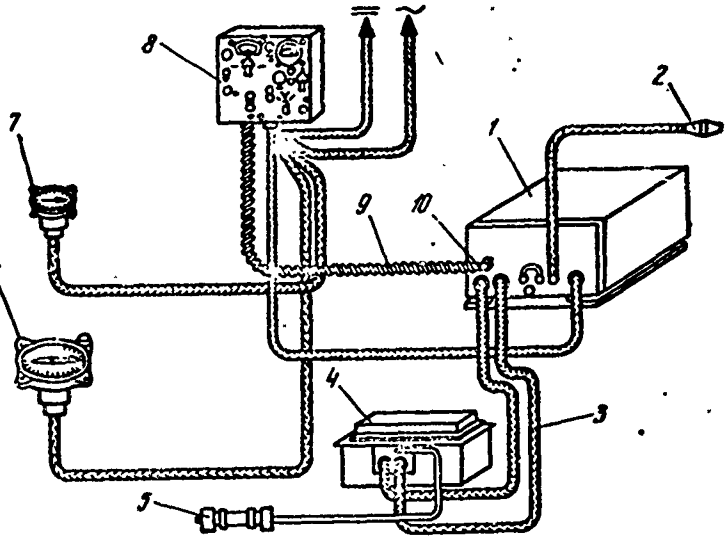

Fig. 129. Semi-mounted diagram of ARK-5: 1 - receiver; 2 - partition insulator; 3 - loop cable; 4 - loop; 5 - dehydrator; 6 - ["SUSh"] "СУШ" indicator; 7 - ["SUP"] "СУП" indicator; 8 - control panel; 9 - flexible shaft; 10 - angular tube.

The loop of the ARK-5 is located in a recess in the upper skin of the fuselage between frames Nos. 7 and 8. The loop dehydrator is attached by means of two clamps to the skin of fuselage along with the loop. The remote control panel of the receiver is located on the instrument panel in the cockpit. The rigid antenna of the ARK-5 is placed between the mast and the tail fairing of the aircraft. The SUP and SUSh course indicators are placed on the instrument panel in the cockpit. The PO-500 converter is located on the floor of the cockpit.

The operating principle of the ARK-5 radio compass is based on the joint utilization of the properties of the directional loop antenna and of the nondirectional - open antenna. Directional radio reception is provided by the loop which has a diagram of reception in the form of a figure eight (Fig. 130). The diagram has two maximums and two minimums of reception. The maximum of reception is obtained when the plane of the loop coincides with the direction to the radio station, and the minimum of reception - when the plane of the loop is located perpendicular to the direction to the radio station.

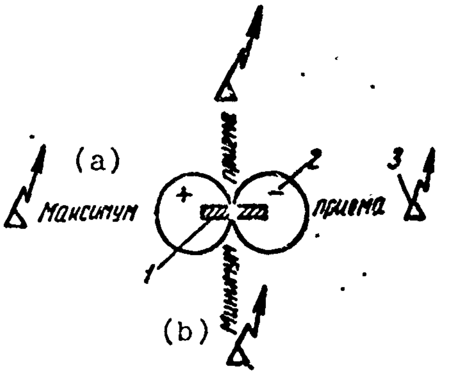

Fig. 130. The diagram of the receiver loop: 1 - loop; 2 - diagram of the receiver loop; 3 - conventional symbol for a radio station.

KEY: (a) Maximum reception; (b) Minimum reception.

When operating the ARK-5 with the function selector switch in the "Loop" position, the readings of the course indicator of the radio compass will have an ambiguity of 180° because the diagram of reception of the loop has two minimums and it is unknown where the radio station is located - in front of or behind the aircraft.

In order to obtain an unambiguous directional reception, in the ARK-5 use is made of combined reception simultaneously on the loop and the open antenna. The diagram of reception on the open antenna has the form of a circumference, i.e., the open antenna possesses nondirectional reception. Such an antenna picks up the signal of radio stations from all directions with identical intensity. Such reception is accomplished during working of the ARK-5 with the function selector switch in the "Antenna" position.

When the ARK-5 is working with the function selector switch on "Compass" a combined reception on the loop and on the open antenna is realized. The diagram of directivity of combined reception is called cardioid. The cardioid (Fig. 131) has one maximum of reception and one minimum of reception.

On the aircraft, the loop of the ARK-5 is installed along the geometrical axis of the aircraft. It operates in such a way that in the "Compass" mode the loop automatically turns to the null reception position, i.e., its plane becomes always perpendicular to the direction of the radio station. The instrument - the course indicator in this case shows the course angle of the radio station (KUR) - the angle included between the longitudinal axis of the aircraft and the direction to the radio station.

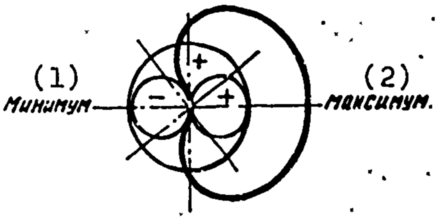

Fig. 131. Cardioid.
KEY: (1) Minimum; (2) Maximum.

The ARK-5 radio compass permits accomplishing three types of operation:

1) auditory nondirectional reception of undamped and modulated oscillations on the open antenna;

2) auditory directional reception of undamped and modulated oscillations on the loop antenna;

3) compass directional reception on the open antenna and the loop - on the visual indicator of the radio compass (on the course indicator).

A Brief Description of the Basic Elements of the ARK-5

The receiver is assembled on 15 tubes, 8 of them operate in the superheterodyne circuit and 7 tubes - in the circuit of automatic control of loop rotation.

The band of the receiver is broken down into three sub-bands: 150-310 kHz, 310-640 kHz and 640-1300 kHz.

The control panel provides remote control of the radio compass. All controls are placed on the front panel of the board and make it possible to perform the following operations:

1. Switching to reception of modulated or unmodulated signals with the "TLF-TLG" switch.

2. Switching the types of operation:

in the "Switched off" position the feed circuits of the radio compass are turned off;

in the "Compass" position the antenna and loop are connected to the receiver and the automatic control device for rotation of the loop is connected;

in the "Antenna" position the antenna is connected to the receiver, and the loop and the device for automatic control of the rotation of the loop is disconnected;

in the "Loop" position, the loop is connected to the receiver, the circuit of manual control of loop rotation is closed and the antenna is disconnected.

3. The receiver is tuned by the knob with the inscription "Tuning." The rotation of the knob is transmitted through a vernier drive to the tuning dial and through a flexible shaft - to the tuning capacitor of the receiver.

The moment of tuning the receiver to the frequency of the transmitting station is recorded by the tuning meter and is determined by the maximum deflection of the needle of the indicator to the right.

4. Switching of the sub-band is by means of the band-

selector switch. The sub-band dial shows the sub-band which corresponds to the position of the switch, and opens the tuning dial which corresponds to the given sub-band.

5. Manual control of the rotation of the loop is by the knob with the inscription "Loop L-P." This switch is used to supply power to the loop rotation motor. Rotation of the loop can be faster or slower. In order for the loop to rotate faster, the switch must be first pushed in, and then pressed to the left or to the right.

6. Volume control is by means of the knob with the inscription "Volume."

7. For illumination of the dials and the tuning meter on the panel there are two connected lamps and two spares. Control of the illumination of the dials is performed by the knob with the inscription "Illumination."

8. Switching control from one panel to another (for the radio compass with two panels) is accomplished by pressing the knob with the inscription "Control" (on the An-2 aircraft there is no second panel).

9. An indicator light with a green jewel serves for monitoring the switching on of the radio compass.

10. Two fuses are installed on the panel. One is in the d-c circuit on 5 A, and the other in the a-c circuit on 2 A.

The loop, possessing directional reception properties, serves for performing the search for the direction to the radio transmitting station to which the receiver has been tuned.

The loop antenna unit includes the loop itself, the electric motor of the loop, the radio deviation compensator and a transmitting selsyn. All these elements are placed in a sealed casing.

On the An-2 aircraft the loop is placed in the upper part of the fuselage flush with the skin of the aircraft in a special metallic recess - the "bath." The loop is connected by two cables to the receiver.

The dehydrator of the loop serves to protect the mechanism of the loop from condensation of moisture in it during the descent of the aircraft from high altitudes. It is a receptacle made of plexiglass in which there are small crystals of silica gel which absorb moisture. Prior to absorption of moisture, the crystals have a dark-blue color. After absorbing moisture they change their color from dark-blue to pink. Pink crystals are already incapable of absorbing moisture. To restore their action, it is necessary to pour them out on a metallic sheet and to dry them on a moderate fire at a temperature of 200-300°C until the appearance of the dark-blue color.

The PO-500 converter serves for conversion of direct current with voltage of 27 V to alternating current with voltage of 115 V with a frequency of 400 Hz.

It must be remembered that the supply voltage of the converter during operation should not be below 23.4 V and not above 28.6 V to avoid putting the starting and controlling apparatus out of commission.

Connection of direct current with incorrect polarity to the system will put the converter out of commission.

The pilot's course indicator "SUP" and the navigator's course indicator "SUSh" show the course angle of the radio station. The scale of the pilot's course indicator is broken into 360° in 5° graduations. The scale of the navigator's course indicator is rotary, and is divided into 360° with 1° graduations.

The scale is turned by the knob with the inscription "Course."

The tuning of the receiver is performed in the following manner:

1) the function selector on the panel is set in the "Antenna" position;

2) the switch for the sub-bands is set in the position corresponding to the frequency of the radio station being received;

3) the PO-500 is turned on by the switch on the pilot's electrical panel;

4) illumination of the dials of the instruments is adjusted by turning the "Illumination" knob;

5) the "Tuning" knob is set to the assigned frequency opposite the cross hairs.

6) wait one-two minutes after switching on the receiver while the tubes warm up, and accurately tune the receiver by rotating the knob in both directions to attain maximum deflection of the needle of the tuning meter to the right;

7) set the volume control to the position of normal signal volume;

8) listen for the call sign and make sure that the receiver has been tuned to the required radio station;

9) set the function selector to the "Compass" position, in so doing, the needle of the course indicator will swing and will indicate the course angle of the radio station.

Flight to the radio station with auditory course indication is used in the event of failure of the automatic rotation of the loop.

In flying to the radio station with auditory course indication it is necessary:

1) from the magnetic compass and chart to set the aircraft approximately in the direction to the radio station;

2) to tune the receiver while the switch is in the "Antenna" position and to check the call signs;

3) to set the switch to the "Loop" position;

4) to set the volume control knob to the position of maximum volume;

5) by using the "Loop L-P" switch, to set the loop to maximum volume;

6) by using the volume control knob to set normal volume;

7) to turn the loop and determine minimum audibility so that the needle of the course indicator of the radio compass will be located in the first or fourth quarter;

8) to note the angle of deflection of the needle relative to zero and by rotation of the loop to set it on zero;

9) to turn the aircraft to the measured angle in that direction to which the needle of the course indicator points and to set the course of the aircraft to minimum audibility of the radio station.

Care of the Radio Compass

1. Check the reliability of the contacts of the antenna input and grounding to the "Antenna" and "Ground" terminals.

2. Check the presence of spare fuses and illumination lamps and, if necessary, replenish the supply.

3. Check the controls to see that there is no jamming.

4. Switch on the radio compass and check it on all types of operation ("Compass," "Antenna" and "Loop"), determine that there is no jamming of the needle of the pilot's and navigator's course indicator, the tuning meter, and see whether the illumination and volume controls are working properly.

5. Make an external inspection of the equipment, check the fastening of the antenna, loop, and cables.

6. In case the apparatus has operated abnormally in the air, check and eliminate the discovered malfunctions; if the malfunction cannot be corrected on the aircraft, then remove the inoperative apparatus and send it to the radio repair shop.

The simplest malfunctions of the ARK-5 and the means of their elimination are given in Table 16.

Table 16.

Malfunction	Cause of malfunction	Means of elimination
When the ARK-5 switch is thrown on the pilot's electrical panel the radio compass does not operate	No contact in the two-prong power supply plug	Press the plug in tighter
When the sub-bands are switched on on the control panels in the receiver the radio stations of the previous sub-band of frequencies are heard	Burnt-out 5 A fuse in the d-c circuit	Replace the fuse on the board
When the ARK-5 is turned on, the green light on the control panel does not light up, there is no reception	Burnt-out 2 A fuse in the a-c circuit on the control panel	The same
When the ARK-5 is switched to work in the "Compass" mode, the needle of the course indicator always slowly rotates in one direction and does not stop in the position of the bearing. There is noise in the earphones and the station is not heard.	A break or short on the housing of the open antenna of the radio compass	Connect the antenna of the RSB-5 to the receiver of the ARK-5
After switching on and warming-up the tubes of the ARK-5, in the earphones stations are not heard and the superhet hum of the receiver is also absent	Burn-out of one of the tubes of the radio compass	Replace all tubes with serviceable ones from spare set

Table 16 (Cont'd.).

Malfunction	Cause of malfunction	Means of elimination
There is no illumination of the dial of the remote control panel	The dial illumination lamps on the panel are burned out	Replace the lamps
In the "Compass" mode the ARK-5 operates normally, gives a correct bearing to the radio station but the radio station itself is not heard in the earphones	1. A burnt-out 6F6 tube in the earphone output	Replace the 6F6 tube in the receiver
	2. The earphones are inoperative	Replace the earphones with serviceable ones

Radio Altimeter RV-2

The RV-2 low-altitude radio altimeter serves for determining the absolute flight altitude of the aircraft above the terrain being flown over.

Unlike a barometric altimeter, the radio altimeter measures the absolute altitude of aircraft over the surface being flown over. Its readings change as a result of change in the terrain features and do not depend upon temperature, barometric pressure, humidity, the speed of flight, or on the nature of the surface being flown over (earth, water, snow, ice).

Individual big buildings, heights, ravines, the shores of rivers and lakes are noted on the altitude indicator by corresponding changes in reading. The radio altimeter indicates the distance from the aircraft to the earth in a vertical line (under the aircraft) and in no way reacts to heights or low places which are located ahead of, in back of or to the side of the aircraft.

The radio altimeter is used in flights under adverse weather conditions without ground visibility, in penetrating low overcast over the airfield, in landing under conditions of poor visibility, and also in conjunction with the other radio navigation facilities in calculating the landing pattern by OSP-N, SP-50 systems, the RV-2 makes it possible to control the letdown from an altitude of 20-30 m. At the same time, the RV-2 can be used for various special purposes where precise measurement of flight altitude is necessary.

In mountainous terrain it is forbidden to use the radio altimeter because under these conditions the RV-2 shows the distance not to the peaks of mountains but to their slopes and, furthermore, the drastic changes in distance from a flying aircraft to the earth can exceed the range of measured altitudes.

With considerable rolling and pitching of the aircraft (more than 45°) the readings of the RV-2 become imprecise and in these cases it is recommended that they not be used.

The RV-2 can measure altitude within limits of from 0 to 1200 m.

The altitude indicator instrument has two scales which correspond to two altitude ranges:

a) the low altitude scale - from 0 to 120 m;
b) the high altitude scale - from 0 to 1200 m.

The accuracy of measurement of altitudes:

a) on the low altitude scale ±2 m ± 5% of measured altitude;

b) on the high altitude scale ±20 m ± 5% of measured altitude;

The weight of the radio altimeter without cables - 14 kg.

The feed circuit is direct current with voltage of 27 V, power consumed is 65 W.

The whole control of the radio altimeter is reduced to switching it on to work and changing from one scale of altitude to the other. The controls are located on the altitude indicator instrument.

During operation in flight, the RV-2 does not require any fine adjustment and correction of measurements.

A semi-mounted diagram of the RV-2 radio altimeter is shown in Fig. 132.

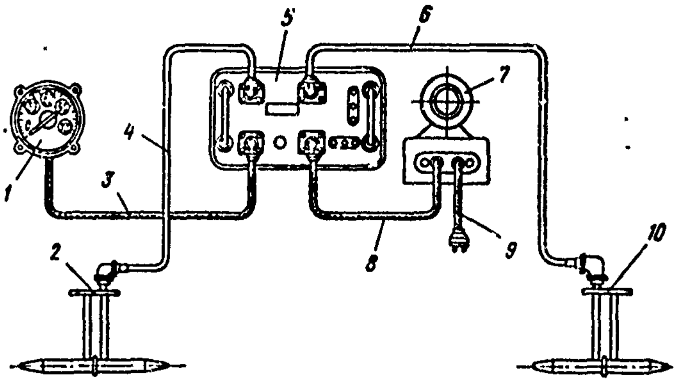

Fig. 132. Semi-mounted diagram of the RV-2 radio altimeter: 1 - indicator; 2 - receiving antenna; 3 - indicator cable; 4 - antenna cable; 5 - transceiver; 6 - antenna cable; 7 - converter; 8 - converter cable; 9 - power supply cable; 10 - transmitting antenna.

The RV-2 radio altimeter assembly includes:

1) the transceiver mounted in one housing;
2) receiving and transmitting antennas;
3) PRV-46 altitude indicator instrument;
4) RU-11AM converter with filter;
5) connecting cables and high-frequency feeders.

The transceiver and RU-11AM converter are installed between frames Nos. 21 and 22 on the port side of the tail section of the fuselage or between frames Nos. 17 and 18.

The PRV-46 altitude indicator instrument is installed in the cockpit on the instrument panel on the left.

The receiving and transmitting antennas are installed in the same line under the aircraft and are attached to the lower skin of the fuselage.

Figure 133 depicts a block diagram of the RV-2 radio altimeter.

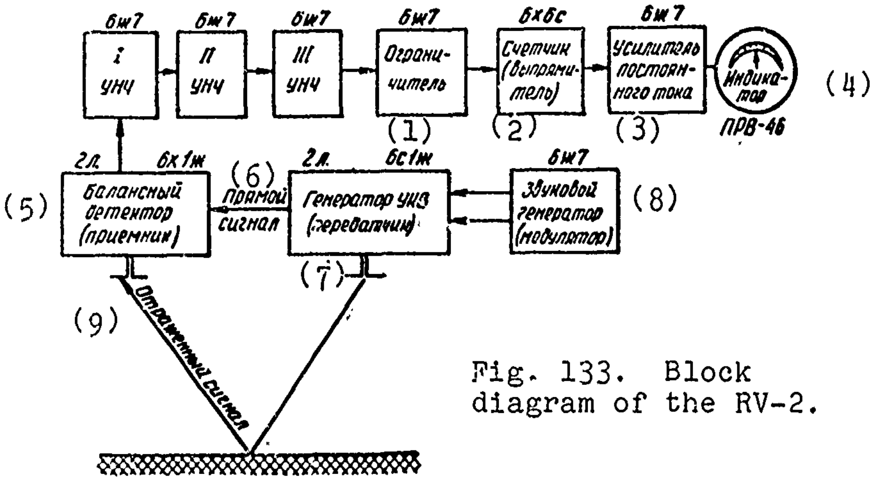
6Ж7
I УНЧ
6Ж7
II УНЧ
6Ж7
III УНЧ
6Ж7
Ограничитель
(1)
6Х6С
Счетчик (выпрямитель)
(2)
6Ж7
Усилитель постоянного тока
(3)
Индикатор
ПРВ-46
(4)
2Л. 6Х1Ж
(5)
Балансный детектор (приемник)
(6)
Прямой сигнал
2Л. 6С1Ж
Генератор УКВ (передатчик)
(7)
6Ж7
Звуковой генератор (модулятор)
(8)
(9)
Отраженный сигнал

Fig. 133. Block diagram of the RV-2.

KEY: (1) Limiter; (2) Counter (rectifier); (3) d-c amplifier; (4) Indicator; (5) Balance detector (receiver) (6) Direct signal; (7) [UKV] УКВ generator (transmitter); (8) Audiofrequency oscillator (modulator); (9) Reflected signal.

Designations: 6Ж7 = 6Zh7; 6X6C = 6Kh6S; 6X1Ж = 6Kh1Zh; 6C1Ж = = 6S1Zh; [UNCh] (УНЧ) = low frequency amplifier; ПРВ-46 = PRV-46; Л. = Tubes.

The operation of the radio altimeter is based on the phenomenon of reflection of radio waves of the ultrashort-wave band from the surface of the earth with the utilization of frequency modulation.

On the front panel of the transceiver there are two high-frequency sockets for connection of the cables from the transmitting and receiving antennas, a socket for connection of the cables from the converter and the indicator, a socket for connection of a 0.25 A fuse. Furthermore, on the right side of the front panel there are the axes of four potentiometers; "Calibration" (low and high altitudes) and the "Zero setting" (low and high altitudes) covered by special dampers.

A shock-absorbing frame protects the transceiver from shocks and vibrations.

The PRV-46 altitude indicator is an amperemeter of direct current whose scale is graduated directly in meters of altitude. The indicator has two knobs. One knob with the inscription "On" serves for switching the radio altimeter on and off, the other, with the inscription "Band" serves for switching the altitude band. When switching bands, the numbering of the scale is switched correspondingly. The altitude indicator is connected with the transceiver by the corresponding cable.

The primary power source of the radio altimeter is the aircraft d-c system with voltage of 27 V.

The RU-11AM converter serves for conversion of the direct current of the aircraft system with voltage of 27 V into direct current with voltage of 220 V necessary for the plate supply of the tubes of the radio altimeter.

The radio altimeter should be switched on for 3-5 min before flight prior to take-off and must be switched off after flight.

Switching on the radio altimeter during layover on the ground is necessary for checking its capacity for work and is performed with the position of the knob of the "Band" indicator corresponding to the low altitude 0-120 m band, for which the "Band" knob is turned to the stop counterclockwise.

Then the indicator knob with the inscription "On" is turned to the right until it clicks. In so doing power is supplied from the aircraft system - the radio altimeter is switched on. In 2-3 min after switching on the indicator needle will go from the extreme left position and will smoothly approach the zero mark of the indicator.

If the air temperature is below minus 30°C, it is recommended that the radio altimeter be switched on for 5-10 min prior to beginning to use it. During take-off and climb, the needle of the RV-2 smoothly climbs from zero and increases the readings, following the change in altitude. At an altitude exceeding 120 m, the needle is set at the right stop. Therefore, after reaching 100 m in altitude, it is necessary to switch the RV-2 over to the high altitude band.

During further climbing of the aircraft, the needle of the indicator will climb smoothly, following the change in altitude, and at an altitude exceeding 1200 m, it will be set at the right stop. Having reached an altitude of 1200 m, the RV-2 must be disconnected because during climb to an altitude of 1400-1600 m and higher, the needle of the indicator begins to shift and to occupy arbitrary positions right down to zero as a result of weakening of the reflected signal.

In flight over uneven terrain, the RV-2 will note the changes in altitude because of the unevenness of the earth's surface.

In flight over the sea, the readings of the RV-2 are steadier than in flight over dry, sandy terrain.

Individual masts, houses, and trees are not recorded by the radio altimeter and only in flight over a dense leafy forest will the RV-2 show the altitude of the aircraft over the trees.

The radio altimeter malfunctions and it is forbidden to use it in the following cases:

1. If on start and in flight within 2-3 min after switching on the needle of the indicator does not move away from the left stop.

2. If on start, with the RV-2 working on the low altitude band, the needle of the indicator moves significantly from the zero mark or behaves restlessly - sharp and great oscillations are observed.

3. If the needle of the indicator stops at some place on the scale and does not react to a change in altitude.

4. If in flight over even terrain within the limits of measurement of the RV-2 on a given band the needle oscillates within great limits (unsteady readings).

5. If the readings of the radio altimeter are evidently overestimated.

Having noted one of the signs of malfunction of the RV-2, it is necessary to report this to a RESOS technician for correction. A malfunction of the RV-2 which can be eliminated in flight, - this is the replacement of burned out 0.25 A fuses on the front panel of the transceiver.

Marker Radio Receiving Equipment
MRP-56P

The MRP-56P marker radio receiving equipment is designed for the reception of UKV-marker radio-range beacons as well as for determining the moment of flight of the aircraft over the antenna of the radio marker beacon. This moment is determined by the lighting of a signal light installed on the pilot's instrument panel and by the ringing of a bell.

The MRP-56P marker radio receiver operates on a frequency of 75 MHz (4 m).

The MRP-56P, unlike the earlier produced MRP-48 receivers, has improved noise immunity both in relation to ultrahigh frequency interferences and in relation to low frequency interferences which appear in the aircraft system from the working of various electrical apparatuses.

The sensitivity of the receiver is 2-4 μV with 30% modulation with a frequency of 3000 Hz and with output current through the coil of 0.8 mA.

The relay of the receiver trips with a current of 0.6 mA and operates reliably with a current of 0.8 mA.

The plate circuits of the receiver are supplied from the ARK-5 radio compass with d-c voltage of +220 V. The current consumed by the plate circuits of receiver does not exceed 12 mA.

The power supply of the filament circuits of the tubes, the electric bell, and the signal light comes from the aircraft system with a voltage of 27.5 V. The current consumed by the filament circuits does not exceed 0.4 A, by the electric bell - 0.3 A, and by the transient relay - 28 mA.

The MRP-56P assembly is shown in Fig. 134.

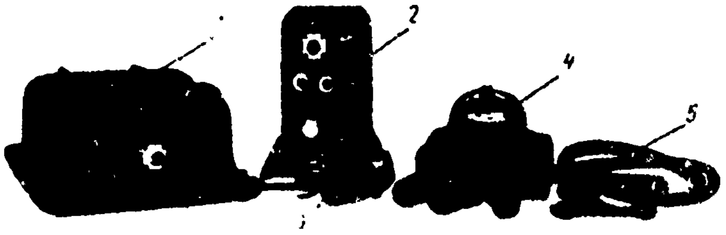

Fig. 134. The MRP-56P marker receiver assembly: 1 - intra-fuselage receiving antenna; 2 - tube radio receiver; 3 - signal light; 4 - bell; 5 - connecting cable and high-frequency feeder.

A receiver of the MRP-56P type is located under the floor of the cockpit. The signal light is located on the pilots' instrument panel. The bell is located in the cockpit over the head of the left pilot. The intra-fuselage antenna is located in a recess in the lower skin of the fuselage and is covered with a plexiglass cover.

Figure 135 shows a block diagram of the receiver. In the MRP-56P receiver, three tubes are used: a 6Zh1P and two 6N3P.

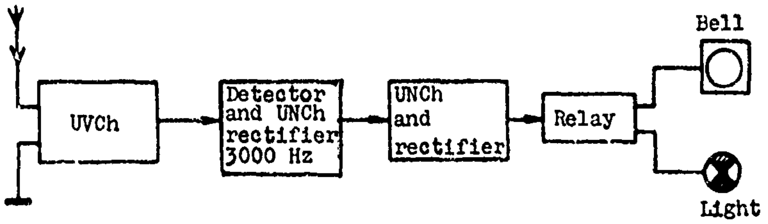

Fig. 135. Block diagram of the MRP-56P receiver.

The operating principle of the marker radio receiving equipment consists in reception and conversion of the high-frequency pulses being emitted by a radio marker beacon into pulses of the same width of direct current, which lights a signal light and rings a bell.

Structurally the MRP-56P marker-receiving device is carried out in the form of two main components: an antenna and receiver, connected by a high-frequency feeder, and a third additional component - the signal unit which combines a transient relay and a bell.

The MRP-56P receiver is mounted on an aluminum chassis with a front panel. On the front panel of the receiver there are the antenna and plug sockets ("Antenna" and "Monitoring"), a quadripole power supply board ("Power supply") and two semivariable capacitors, the axes of the rotors of which are brought out to the face of the panel and are designated: "Monitoring I" and "Monitoring II." The axes of the rotors have slits for the fine adjustment of the receiver by means of a screwdriver. The chassis with the front panel enters an aluminum housing and is attached by two screws.

During operation in flight, the MRP-56P radio receiving equipment does not require any tuning and fine adjustment. The whole control is reduced only to throwing the "MRP" switch on the pilot's electrical panel. In so doing, it is necessary to remember that the MRP-56P will operate only at with the ARK-5 radio compass switched on because the high voltage current enters it from the receiver of the radio compass.

The place of installation of the intra-fuselage antenna in the bottom part of fuselage is selected in such a way that on take-off and landing the plexiglass cap is not showered by gravel. When painting the aircraft it is necessary to watch out that the surface of the plexiglass cap does not get painted.

The MRP-56P radio receiver is tuned to a frequency of 75 MHz and its operation on the ground is checked by a RESOS technician with the help of special instruments.

Aircraft Intercom Device SPU-5

The SPU-5 aircraft intercom device is designed for intra-aircraft telephone communication between all members of the crew, for access of a member of crew to external radio communications, and also for working with the radio compass.

The SPU-5 assembly consists of an amplifier, RU-11AM converter, three subscriber sets, a connecting panel and two K-4M buttons. The amplifier and converter are located under the floor of the cockpit between frames Nos. 4 and 5 on the left side. The subscriber set of the left pilot is located on the left side on the canopy frame. The subscriber set of the right pilot (the navigator) is located on the right side between frames Nos. 3 and 4 on the canopy frame. The subscriber set of the operator of the drift indicator is installed in the cabin on the right side between frames Nos. 12 and 13.

The connecting block is installed under the floor of the cockpit on frame No. 4. K-4M knobs are located on the right and left control columns.

Three plugs come out from the connecting block on frame No. 4. They are connected as follows: the first - to the ARK-5 panel, the second - to the US-9DM receiver, the third - to the sockets of the power element of the RSB-5.

Switching of the SPU-5 is accomplished by means of a switch on the subscriber panels and the control pushbuttons.

Basic specifications SPU-5

Amplifier and RU-11AM converter are supplied with voltage, V................	27 ± 10%
Amplifier on three-six pairs of TA-4 phones during operation from LA-5 throat microphones provides output voltage, V............................	70

Non-linear distortions of the amplifier, %	do not exceed 15
Throat microphone supply voltage, V	3-4

The SPU-5 aircraft intercom device is installed on An-2 aircraft up to 79th series. On aircraft after the 79th series SPU-6 are installed.

The amplifier of the SPU-5 is a three-stage low frequency amplifier built on three 6N7 tubes, and serves for amplifying the audio frequency supplied from the throat microphones.

The first amplifier stage operates on a phase inverter circuit, i.e., gives on output two voltages equal in value, out-of-phase 180°. This is necessary because the subsequent amplifier stages operate on a two-cycle circuit. The second stage is the penultimate. It serves for driving the output stage and is assembled on a two-stage circuit. The third - the output stage operates as the power amplifier. It is assembled on a two-stage circuit with transformer output. The power supply of the anode circuits of the amplifier tubes is accomplished by a voltage of 220 V supplied from the RU-11AM converter. Amplification control is accomplished by a regulator located on the amplifier. Furthermore, volume can be regulated by rheostats located on the subscriber panels.

The subscriber sets are switching devices which make it possible for every member of the crew to call and establish communication with the other subscribers, and also to operate on radio. Commutation is accomplished by a switch on six positions: 1) "РК" ["RK"] - radio compass; 2) "КР" ["KR"] - command radio set; 3) "СР" ["SR"] - communications radio set; 4) "СЛ" ["SL"] - listen; 5) "ГВ" ["GV"] - talk; 6) "Выз." ["Vyz."] - call.

The "Vyz." position is not a fixed one, and upon releasing the knob, the switch automatically returns to the "GV" position.

The intercom headset is connected to the apparatus through a cord which terminates in half of split plug. On the upper lid of the apparatus there is the volume control.

Operation of the SPU-5

The SPU-5 must be switched on at the take-off of the aircraft and remain on for the whole time of the flight. The SPU-5 is switched on by the AZS on the pilot's central electrical panel.

Internal telephone communication between the members of the crew is accomplished with the switch in the position "GV" (talk). If necessary, a crew member converses via external communication, then it is possible to call by voice by switching the switch of his subscriber apparatus to the "Vyz." (call) position. The crew member being called places the switch on his apparatus in the "GV" position and answers the caller.

When it is not required in conversation, the switch of the subscriber paratus should be in "SL" (Listen) position.

External communication by any of the crew is accomplished with the switch of the subscriber appartus in the "KP" (command radio set) or "SR" (communications radio set) position. In this case the earphones and the throat microphones of the given subscriber are connected to one radio set or the other. Wit the switch in the "RK" position the headset of the given subscriber is connected to the radio compass.

To ensure reliable operation of the SPU-5 it is necessary to check:

1) the condition of the connection of the plug of the ARK-5 panel and the US-9DM receiver and of the power element of the RSB-5; the spacer screws of the "L" and "T" boards must be tightened as far as they will go;

2) the reliability of the contacts in the connecting cables; in this case to tighten the nuts of the couplings of the amplifier;

3) the reliability of contacts in the connection block of the intercom headset;

4) the amplification control knob (on the amplifier) and the volume control knobs on the subscriber panels to set them in the extreme right position;

5) the functioning of the intercom device;

a) whether there is internal communication between the members of the crew;

b) the presence of modulation of the transmitter when working on radio communication;

c) whether the signals of the US-9DM receiver, and the radio compass ARK-5 are being received.

Aircraft Intercom Device SUP-6

The SUP-6 aircraft intercom device is intended for intra-aircraft telephone communication between eight subscribers in either of two networks (network 1 or network 2) and to provide the subscribers with access to external radio communication through the two radio sets.

On the An-2 aircraft the SPU-6 are used for communication between three subscribers and for access to external radio communication via the two radio sets and one radio compass.

The aircraft intercom device provides:

1. Two-way voice intercommunication between subscribers in two communication networks through the corresponding amplifier of the SPU when the "SPU-Radio" toggle switch is set on the subscriber apparatus and the "Network" toggle switch is set to one of the networks (network 1 or network 2) - when the four-position "Radio" remote knob is pressed. On the An-2 aircraft network 1 is provided.

In internal communication the subscriber simultaneously listens on reduced volume to the radio receiver of that set to which the radio communications switch of his subscriber apparatus has been set.

2. The possibility of transferring each subscriber of one intercom network to another by means of the "Network" switch on the subscriber apparatus.

3. Realization by each subscriber of internal conference communication with all the other subscribers when he presses his "ЦВ" ["TsV"] conference call button with any position of the knob of the radio communications switch and the switches on the subscriber apparatus.

In this case, there is simultaneously accomplished predominant listening to the signal of that radio receiver to his radio communication switch which has been set, and preferential reception of his radio receiver is effected when any other subscriber presses his own "TsV" conference call button.

4. The presence in the headsets of each subscriber of the signals of the corresponding radio receivers on all positions of the knob of the radio communications switch - with the pressing of the buttons and the setting of the "SPU-Radio" switch of the subscriber apparatus to the "Radio" position.

5. Realization by every subscriber of transition from external communication to the corresponding intercom network with any position of the knob of the radio communications switch and the "SPU-Radio" switch by means of pressing the special remote four-position "SPU" knob.

6. Realization by every subscriber of starting the converter and modulation of the radio transmitters at two positions of the knob of the radio communications switch when the "SPU-Radio" switch on the subscriber apparatus is set to the "Radio" position and the connection of the throad microphones of the subscriber are connected to the input of the appropriate transmitter when the four-position "Radio" knob is pressed.

7. Smooth adjustment of the level of speech being transmitted on the internal or external communication network by the "General" volume control and the audio level of the external communication network during work on the intercom network by the "Radio" volume control.

Assembly SPU-6

The SPU-6 of aircraft intercom assembly (on An-2 aircraft) includes the following main elements:

1) amplifier;
2) three subscriber sets;
3) connecting block;
4) four-position K-4M knob;

Basic specifications SPU-6

Rated power supply voltage:	
alternating current circuit:	
voltage, V	115
frequency, Hz	[illegible]
direct current circuit, V	27
Power supply of plate circuits of the amplifier is accomplished on the alternating current circuit from the rectifier located in one unit with the amplifier. The filament circuits of the amplifier are supplied from the alternating current circuit with a voltage, V	6.3
Power consumed:	
on the alternating current circuit of 115 V, 400 Hz, W	25
on the direct current circuit with voltage of 27 V, W	23
Output voltage of the amplifier, V	45-70
Coefficient of non-linear distortions, %	not more than 8
Supply voltage of the throat microphones, V	3-5
The amplifier by means of barometric relays ensures an automatic increase in amplification in two stages:	
at an altitude of 5-6 km	approximately 1.8 times
at an altitude of 7-8 km	approximately 2.6 times

The amplifier of the SPU-6 is intended for amplification of weak signals coming from the throat microphones, and obtaining on output sufficient power for servicing eight subscribers. It is a three-stage low-frequency amplifier which operates on two miniature tubes of the 6N1P series (twin triode).

A characteristic feature of the amplifier of the SPU-6 is that it has two barometric relays installed on it which ensure an increase in amplification during climb to an altitude of more than 5000 m. The need for an increase in amplification with altitude is determined by the fact that both the vocal apparatus of man and his ear, and also the headset operate less effectively under conditions of rarefied air.

Both barometric relays are similar in construction. Each consists of an aneroid unit and a microswitch.

With a climb to an altitude of more than 5000-6000 m, the microswitch is tripped and the alternating voltage on the grid of the first triode of amplifier increases; amplification is almost doubled.

During climb to an altitude of 7000-8000 m, because of the switching of the contacts of the microswitch, the grid of the tube is supplied with full input voltage. In so doing, as compared with altitudes of 5000-6000 m, amplification is increased almost three times.

The level of audio amplification can be regulated manually with the help of the variable resistance, the axis of which is brought out to the front wall of the chassis of the amplifier. The normal position of the regulator is such that it corresponds to the alignment of the slot of the axis with graduation mark on the front wall of the chassis of the amplifier.

The subscriber set (Fig. 136) serves for connecting the throat microphones and headsets of the subscriber to various communication facilities, and also serves for commutation of the feed circuits of the initiating relay of the converter of the radio transmitter.

The subscriber sets provide:

a) the possibility of conducting two-way voice conversations over the aircraft intercom;

b) the conduct of two-way external communication through the communication and the command radio sets and the reception of signals from the radio compass;

c) realization by any subscriber of a conference call by voice with the other subscribers;

d) smooth adjustment of the level of the signal entering the headsets via both the internal and external communications networks;

e) listening with reduced volume to the signal of that radio set to which the radio communications switch is set during the switchover of subscribers to the aircraft intercom system.

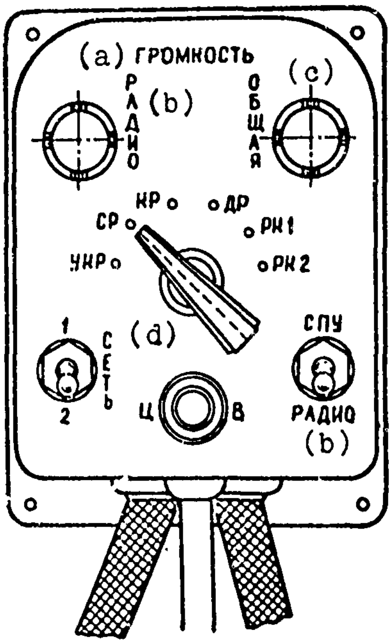

Fig. 136. Subscriber set SPU-6.

KEY: (a) Volume; (b) Radio; (c) General; (d) Network.

Provision for all the foregoing commutations is accomplished by switching the "SPU-Radio" toggle switch,the radio communications switch, by pressing the "TsV" conference call button on the subscriber set and by utilizing the remote four-position "Radio" and "SPU" knobs.

Operation of the SPU-6

Before flight, the SPU-6 must be checked for the various forms of communication in the sequence indicated below.

Access of the subscriber to external communication:

a) the radio communications switch is set in the "UKR" position, and the "SPU-Radio" switch in the "Radio" position. With the indicated positions of the switches the headsets are connected to the output of the receiver of the UKV-radio set, and the throat microphones through the four-position "Radio" knob to the input of the transmitter in the given radio set. Through the knob there will be supplied the minus of the power supply of the initiating relay of the radio set.

To transmit, it is necessary to press the "Radio" button on the control column. The volume of sound is set by rotation of the "General" volume control knob on the subscriber set;

b) the radio communication switch is set in the "SR" position, and the "SPU-Radio" switch - in the "Radio" position. In so doing, the headsets are connected to the output of the receiver of the communications radio set, and the throat microphones through the "Radio" button on the control column - to the input of RSB-5 transmitter, through the knob will move the minus to the initiating relay of the RUK-300B converter.

To transmit, it is necessary to press the remote "Radio" button. The volume of sound in the headsets is set by rotation of the "General" volume control knob on the subscriber set;

c) the radio communications switch is set in the "KR" position and the "SPU-Radio" switch - in "Radio" position.

In so doing, the headsets are connected to the output of the receiver (RSIU-3M) of the given radio set, and the throat microphones through the "Radio" button - to the transmitter of the given set. Through the knob will move the minus to the initiating relay of the converter of the radio set. To transmit, it is necessary to press the "Radio" button;

d) the radio communications switch is set in the "RK-1" position, and the "SPU-Radio" switch - in the "Radio" position. In so doing, the headsets are connected to the output of the receiver of the radio compass, and the throat microphones are disconnected.

The volume of sound is set by rotating the "General" volume control knob on the subscriber set.

During proper working of the SPU-6, in the subscriber headsets there should be heard the working of the receiver of that radio set to which the radio communications switch has been set, and the subscriber throat microphones should modulate the radio transmitter of this radio set.

Access of the subscriber to the aircraft intercom network. The "SPU-Radio" on the subscriber set is set in the "SPU" position and the radio communications switch can be located in any external communications position. With the indicated positions of the switches, the headsets are connected to the output of one of the SPU amplifiers, and the throat microphones through the four-position "Radio" knob - to the input of this amplifier.

To transmit, it is necessary to press the remote four-position "Radio" knob.

In conducting internal communications, the receiver of the radio set to which the radio communications switch is set is heard in the headsets with reduced volume as compared with the signal being transmitted on the intercom network because of the presence of an autotransformer in the circuit of the headsets.

The level of the signal coming from the output of the amplifier of the SPU is controlled by rotating the "General" volume control knob and the signal coming from the output of the radio communication receiver, - by rotating the "Radio" volume control knob.

Conference call. For conference communication between subscribers (voice call by any subscriber) it is necessary to press the four-position "TsV" conference call button located on the subscriber set.

The radio communications switches "SPU-Radio" and "Network" of the subscriber set in this case can be located in any position. When the "TsV" button is pressed the headsets of all subscribers are connected to the output of the amplifier of that network to which the "Network" switch of the given subscriber set is set.

The throat microphones of the subscriber who pressed the "TsV" conference call button, through the contacts of this button are switched to the input of both SPU amplifiers (since the inputs of the amplifiers are in parallel) regardless of the position of the "Network" switch on the subscriber set.

The throat microphones of all the other subscribers remain connected to those forms of communication to which they were connected prior to receiving the conference call.

The subscriber who pressed the conference call button calls by voice the subscriber he needs and releases the button.

After this, the called and calling subscribers in order to converse must shift over to the internal communication network, i.e., set the "SPU-Radio" switch in the "SPU" position and press the remote four-position "Radio" button.

§ 36. INSTRUMENTS OF An-2 AIRCRAFT

The instruments on the aircraft are designed for monitoring the engine operation and flight conditions of the aircraft. The set of instruments installed on the aircraft makes it possible to perform safe flight at any time of the year and day, and also under adverse weather conditions.

Aircraft instruments, depending on their application, are subdivided into the following:

1) instruments monitoring engine operation;

2) navigation and flight instruments;

3) auxiliary instruments.

All the engine operation monitoring instruments are electrical, remote type, with the exception of the MV-16 vacuum manometer, which is a pressure instrument.

From navigation and flight instruments the altimeter VD-10, magnetic compass KI-13, speed indicator US-350 and rate-of-climb indicator VR-10 are not electric.

Electrical instruments are characterized by the high precision of readings, small overall size of indicators, the absence of delay in readings and by reliability.

The principle of operation of remote electrical instruments consists of measurement of a nonelectric magnitude with the aid of electricity. The instrument consists of transmitter and indicator. The transmitter perceives the nonelectric magnitude, converts it into electrical and sends to the indicator along wires. The indicator measures current, and the calibration of the scale is to the measured nonelectric magnitude.

Instrument panel (Fig. 137) consists of the main panel, right and left removable panels and hinged central panel.

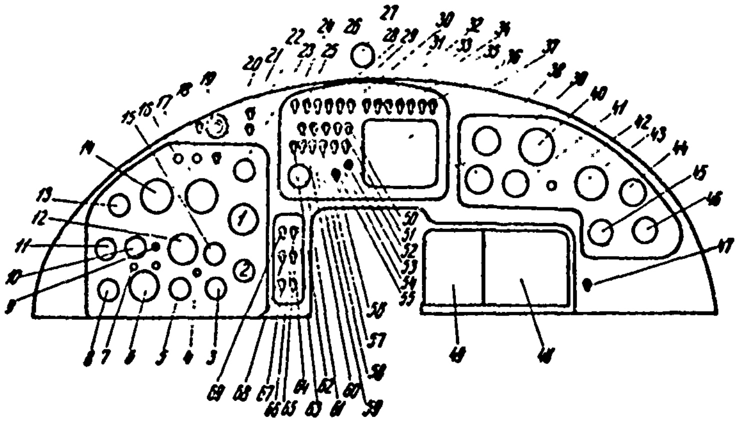

Fig. 137. Instrument panel: 1 - three-pointer EMI-3K indicator; 2 - TTsT-13 cylinder thermometer; 3 - MV-16 vacuum manometer; 4 - MRP-48 signalling; 5 - TUE-48 carburetor thermometer; 6 - SBES-1447 fuel gauge; 7 - signal of fuel remainder in the left wing; 8 - PRV-46 radio altimeter indicator; 9, 42 - GIK-1 rapid adjustment knob; 10 - VR-10 rate-of-climb indicator; 11 - VD-10 altimeter; 12 - UGR-1 gyro-induction compass indicator; 13 - US-350 speed indicator; 14 - AGK-47B gyrohorizon; 15 - TE-45 tachometer; 16 - fire warning monitor; 17 - GPK-48 directional gyroscope; 18 - fire warning light; 19 - PM-1 ignition switch; 20 - fire extinguisher actuation button; 21 - manual starter actuation; 22 - KS-5 starter button (switch); 23 - A-1 amperemeter; 24 - AZS-15 of upper flaps; 25 - AZS-5 of flap control; 26 - AZS-15 of lower flaps; 27 - KI-13 compass; 28 - AZS-5 of aileron trim tab; 29 - AZS-5 of elevator trim tab; 30 - AZS-5 of rudder trim tab; 31 - AZS-5 of command radio; 32 - AZS-5 of intercom; 33 - AZS-40 of communications radio; 34 - AZS-5 of RV-2 radio altimeter; 35 - AZS-5 of ARK-5 radio compass; 36 - V-45 switch of MRP-48; 37 - ARK-5 panel; 38 - AChKhO clock; 39 - US-350 speed indicator; 40 - AGK-47B gyrohorizon; 41 - TUE-48 free-air thermometer; 43 - UGK-2 gyro-induction compass indicator; 44 - EV-46 voltmeter; 45 - VR-10 rate-of-climb indicator; 46 - VD-10 altimeter; 47 - AZS-5 of AChKhO heating; 48 - US 9DM panel; 49 - SUSh-7 radio compass indicator; 50 - AZS-5 of illumination of KI-13 compass, KLSRK right, cabin dome light and tail light; 51 - AZS-5 of horn, illumination behind the panel, dome light in the fuselage, door signal; 52 - AZS-5 of illumination under floor, ultraviolet illumination of central panel; 53 - signal of stand-by PO-500; 54 - AZS-5 of portable light socket, UFO (ultraviolet illumination) on rod, illumination of communications radio, illumination of AB-52; 55 - PO-500 switch; 56 - AZS-5 of fire-extinguisher equipment; 57 - AZS-5 of UFO of the right side of left panel, KLSRK left; 58 - AZS-10 of cowl flaps; 59 - AZS-5 of PVD heating; 60 - AZS-10 of oil cooler flaps; 61 - V-45 fuselage illumination switch; 62 - V-45 cabin illumination switch; 63 - VA-3 voltampere meter; 64 - AZS-5 of lower formation lights; 66 - AZS-15 of right headlight; 65 - AZS-5 of taxiing light; 67 - AZS-5 of upper formation lights; 68 - AZS-5 of ANO (navigation lights); 69 - AZS-15 of left headlight.

On the main panel are located the AZS-20 circuit breaker of the starting system, PM-1 magneto switch, KS-3 starter button (or switch), manual engagement handle of the starter dog, AZS-5 of AChKhO clock heating. The main panel is attached to the front section of the fuselage, to the central panel and to rigidity of attachment of the lower shock absorbers with screws with anchor nuts.

On the left panel are located the US-350 speed indicator, AGK-47B gyrohorizon, GPK-48 directional gyroscope, A-1 generator amperemeter with signal light, VD-10 altimeter, VR-10 rate-of-climb indicator, UGR-1 gyroscopic induction compass indicator, TE-45 tachometer, EMI-3K three-pointer indicator, PRV-46 radio altimeter indicator, SBES-1447 fuel gauge, TUE-48 carburetor thermometer, MV-16 vacuum manometer, TTsT-13 cylinder thermometer, marker equipment signal lights, fire-extinguishing equipment buttons and warning lights, GIK-1 compass rapid adjustment knob.

The left panel is attached to the main with four No. 2 type spring shock absorbers of NISO (Scientific Institute of Aircraft Equipment). For convenience of access to the back side of the instrument panel the left panel is made hinged and is held with a strap.

On the right panel are installed AChKhO clock, AGK-47B gyrohorizon, US-350 speed indicator, TUE-48 free-air thermometer, UGK-2 gyroscopic induction compass indicator, EV-46 voltmeter, VR-10 rate-of-climb indicator, VD-10 altimeter, compass rapid adjustment knob. The right panel is attached to the main with four No. 1 type spring shock absorbers of NISO.

On the central panel are located: circuit breakers, control panel of ARK-5 radio compass, VA-3 voltampere meter of aircraft electrical wiring system, PO-500 switch, stand-by PO-500 signal light. The central panel is attached to the main panel with the aid of two hinges and is held by two spring locks. The panel is held in the deflected position by a special strap. With deflection behind the instrument panel a light turns on for illumination of the back of the instrument panel.

Left panel (Fig. 138). On a panel of the left panel are installed AZS-5 of oil dilution, circuit breaker of window heating and windshield wipers, V-45 switches of windshield wipers, 80 kgf/cm^2 air pressure gauge, 12 kgf/cm^2 air pressure gauge, air pressure gauge of the control cylinder of agricultural equipment, fuel gauge switch, fuel pump circuit breaker, handle of fourway fuel system valve, air system charging valve, panel rheostat, priming pump.

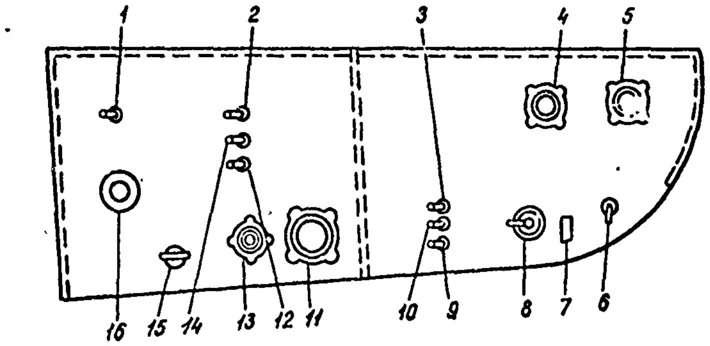

Fig. 138. Left panel: 1 - AZS-5 of oil dilution; 2 - AZS-5 of window heating; 3 - AZS-10 of windshield wipers; 4 - air pressure gauge of agricultural control cylinders; 5 - two-pointer brake pressure gauge at 12 kgf/cm^2; 6 - 2PPN-45 fuel gauge switch; 7 - AZS-15 of fuel pump; 8 - handle of fourway cock; 9 and 10 - V-45 switch of left and right windshield wipers; 11 - 80 kgf/cm^2 air pressure gauge; 12 - AZS-20 of middle window; 13 - air system charging valve; 14 - AZS-25 of side window; 15 - RUFO-48 panel rheostat; 16 - priming pump.

Central panel (Fig. 139). On the panel of the central display are located flap retraction knob, the pressure switches of the trim tabs of elevator, rudder, ailerons, trim tab neutral position signal light, oil cooler flap pressure switch, cowl flap pressure switch, altitude mixture control quadrant, throttle quadrant engine with flap lowering button, propeller pitch control quadrant,

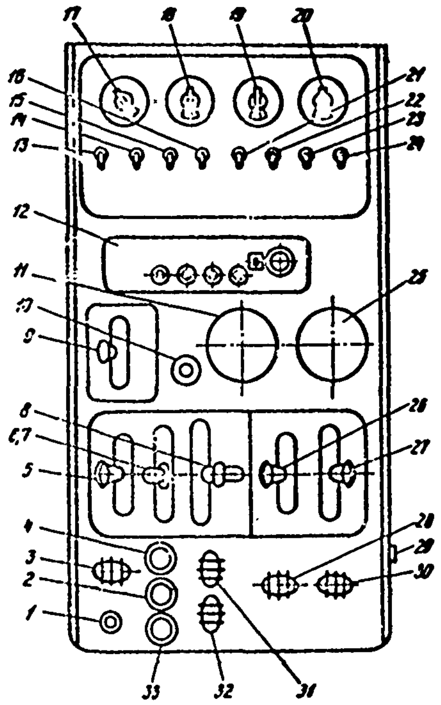

Fig. 139. Central panel: 1 - flap raising button; 2 - elevator trim tab indicator; 3 - elevator trim tab switch; 4 - rudder trim tab indicator; 5 - altitude mixture control quadrant; 6 - throttle control; 7 - flap lowering button; 8 - propeller pitch quadrant; 9 - suction pipe filter quadrant; 10 - door opening indicator; 11 - UZP-47 flap indicator; 12 - command radio control panel; 13 - V-45 generator switch; 14 - V-45 battery switch; 15 - AZS-5 of AGK-47B and GPK-48; 16 - V-45 switch of GIK-1 and AGK-47B; 17 - rheostat of left ultraviolet illumination (UFO) light; 18 - rheostat of central front UFO light; 19 - rheostat of central back UFO light; 20 - rheostat of right UFO light; 21 - AZS-5 of fuel gauge; 22 - AZS-5 of three-pointer indicator; 23 - AZS-5 of flap indicator, oil cooler flap indicator; 24 - AZS-5 of carburetor temperature, free-air temperature and GSN-3000; 25 - UZP-48 oil cooler flap indicator; 26 - carburetor heating control quadrant; 27 - engine shut-off quadrant; 28 - the oil cooler flap switch; 29 - fire-fighter jump signal button (3); 30 - cowl flap switch; 31 - rudder trim tab switch; 32 - aileron trim tab switch; 33 - aileron trim tab indicator.

carburetor heating control quadrant, engine shut-off quadrant, horn button, door warning light, suction pipe filter control quadrant, switches and circuit breakers, rheostats of UFO lights, command radio control panel, UZP-2 or UZP-47 flap position indicator and UPZ-48 oil cooler flap position indicator.

The central panel is bolted to frame No. 1, the cockpit floor and the stiffeners of the instrument panel.

Instruments Monitoring Engine Operation

Three-pointer EMI-3K Electrical Motor Indicator

The three-pointer electrical motor indicator is intended for remote monitoring of the engine operation. It measures the fuel pressure, the oil pressure and temperature. The three pointers on the dial show the measured magnitudes.

The EMI-3K instrument (Fig. 140) consists of electrical remote indicator 3, fuel pressure gauge receiver 4, oil pressure gauge receiver 1 and oil temperature thermometer receiver 2.

The indicator unites three meters in one housing, each of which in the assembly with its receiver forms an independent electrical circuit.

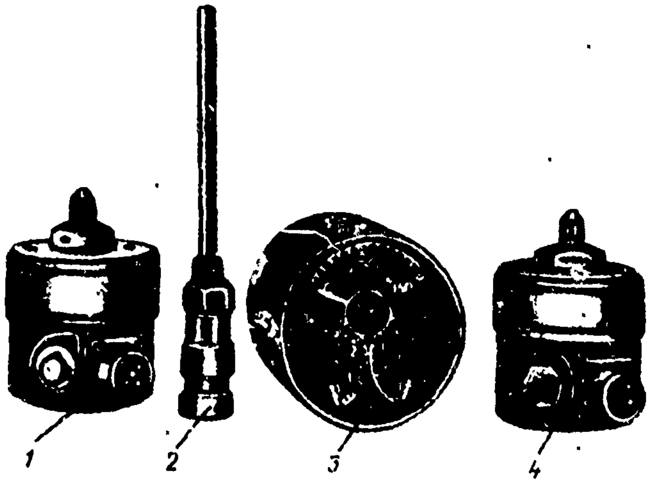

Fig. 140. EMI-3K instrument.

The instrument shows the gauge pressure of fuel from 0 to 1 kgf/cm^2, the oil pressure from 0 to 15 kgf/cm^2 and the oil temperature from 0 to 150°C.

The fuel pressure gauge (Fig. 141). The principle of operation of the pressure receiver is based on the elastic properties of corrugated diaphragms. The differential fuel pressure manometer measures the difference between fuel and atmospheric pressure. The fuel pressure is perceived by the elastic corrugated diaphragm placed in the housing of the receiver. The sealed housing of the manometer is connected with the atmosphere. With increase in pressure the diaphragm is deflected and through the transmitting

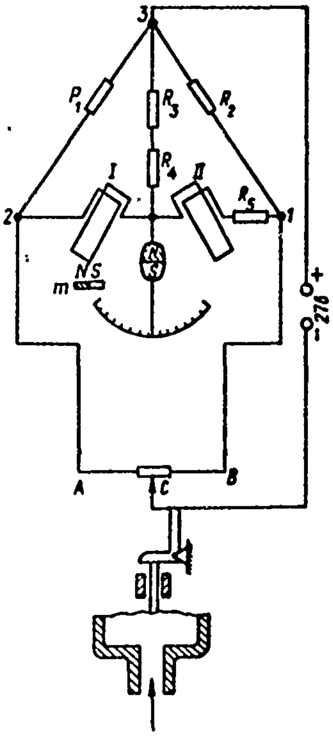

Fig. 141. The measuring circuit of fuel pressure gauge.

mechanism brush C is moved along potentiometer AB. To each difference in the fuel and atmospheric pressures on the diaphragm there will correspond a fully determined position of the brush on the potentiometer. The relationship of the arms of potentiometer AC and CB is measured by the moving-coil logometer of the indicator, which consists of two fixed gates I and II, arranged at a 120° angle. Inside the gates is placed a movable magnet with pointer.

A permanent magnet is installed through the resultant of the magnetic field of gates, which is determined by the relationship of the magnetic fields of gates and, consequently, by the relationship of the arms of the potentiometer of the receiver. The instrument does not react to the current variation in the aircraft electrical wiring system because the relationship of currents in the gates is not changed, and therefore the direction of the resultant remains as previous. After shutting off, the pointer of the instrument returns to the initial position with additional magnet.

The oil pressure gauge has a circuit similar to the fuel pressure gauge, and is distinguished from it by a different connection of the conductor leads from potentiometer AB and by the position of the returning magnet, and also by a more elastic corrugated diaphragm.

Oil thermometer (Fig. 142). The principle of operation of the oil thermometer is based on the property of the heat-sensitive element of the receiver (nickel wire) to change its electric resistance with the temperature shift. Furthermore, to each temperature corresponds little more than one magnitude of resistance of the heat-sensitive element.

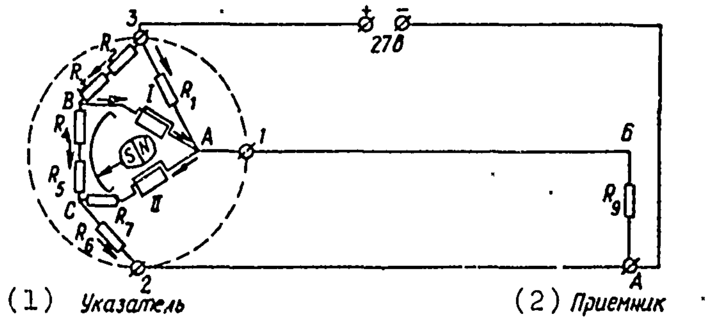

Fig. 142. The measuring circuit of the oil thermometer.
KEY: (1) Indicator; (2) Receiver.

The indicator is a moving-coil logometer, which in its construction is similar to the manometer indicator. At temperature 0°C the resistance of the receiver will be minimum, the potentials of points A and C will be identical, but the potential of point B will be greater than at point A and current will pass through gate 1. There will not be current in gate II. Permanent magnet with pointer will be installed in the plane of gate I, and the pointer on the scale will show 0°C.

With an increase in the temperature of the receiver its resistance is increased, which leads to increase in the potential of point A, and at temperature +75°C the potential difference between points B and A and between A and C will be identical. With this the current flows from point B to A and from A to C and currents in the gates will be identical. The permanent magnet with pointer will occupy the midposition (between gates), the pointer on the scale will show +75°C.

With further increase in the temperature of the receiver the potential of point A will approach the potential of point B and increasingly exceed potential C. This leads to an increase of current in gate II and to decrease of current in gate I. At temperature +150°C in gate II the current will become maximum, but there will not be current in gate I. Permanent magnet with pointer will be installed in the plane of gate II, and the pointer on the scale will show +150°C. In the zero position the pointer returns with additional magnet. Copper resistors R_2 and R_4 serve for elimination of the temperature errors of the logometer gates.

Permissible instrument errors: error of fuel pressure gauge at marks of the scale: 0, 0.2, 0.4, 0.6 at temperature +20°C comprises ±0.04 kgf/cm^2 and at temperatures +50-60°C comprises ±0.06 kgf/cm^2 at mark 0.8; at temperature +20°C it comprises ±0.08 kgf/cm^2.

The error of the oil pressure gauge at marks of the scale 2, 4, 8, 13 at temperature +20°C comprises ±0.6 kgf/cm^2 and at temperatures +50, -45, -60°C - ±0.9 kgf/cm^2, at marks 0, 15 at temperature +20°C - ±1 kgf/cm^2.

The error of the oil thermometer at the mark of scale +100°C comprises ±5°C and at mark 0° - ±10°C.

SBES-1447 Fuel Gauge

The electrical summing fuel gauge is designed for measurement of the quantity of fuel in tanks. With the aid of this fuel gauge it is possible to measure the quantity of fuel in each group of tanks individually and the sum of fuel in both groups. The fuel gauge is also equipped with red signal lights, each of which lights up if 55 *l* of fuel remained in the group.

The operation of the electrical summing fuel gauge is based on the conversion of nonelectric magnitude of the fuel level in tanks into electrical, which is measured with the aid of ratiometric indicator.

The fuel gauge consists of a transmitter and indicator, connected by remote connection. The transmitter consists of a float, which through a system of levers and a corrugated box is connected with the sliding contact of the potentiometer. The corrugated box of the transmitter keeps fuel vapors clear of the potentiometer chamber. With use of fuel in the tank the sliding contact is moved along the potentiometer. The indicator is a logometer with two movable gates and a fixed magnet. When the sliding contact moves along the potentiometer, current redistribution occurs in the gates of the logometer. As a result of the interaction of resultant of the magnetic field of gates with the magnetic field of the permanent magnet gates are turned and the pointer of attachment on the axis of gates will show the quantity of fuel in the tanks (Fig. 143).

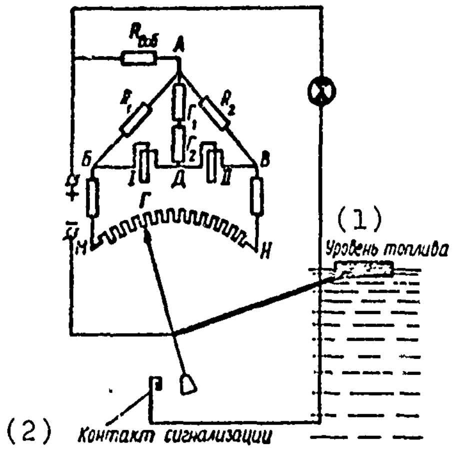

Fig. 143. Fundamental electrical circuit of the fuel gauge.
KEY: (1) Fuel level; (2) Signal contact.

On the An-2 aircraft the fuel gauge transmitters are installed in each fuel tank in special throats at 85 and 87° angles to the axes of the tank (Fig. 144) for horizontal position of the flanges of transmitters during flight of the aircraft.

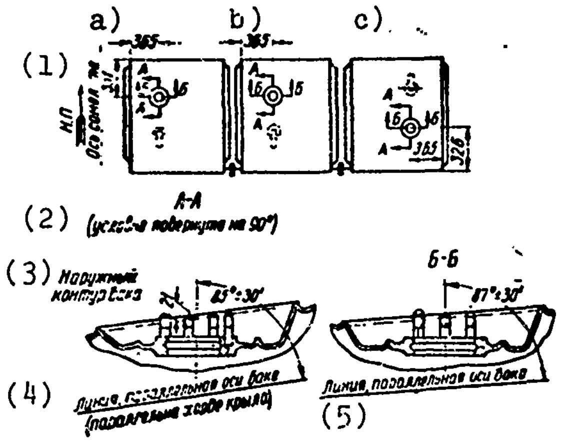
a)
b)
c)
365
365
(1)
НП
Ось самолета
А
Б
365
326
(2)
А-А
(условно повернуто на 90°)
(3)
Наружный контур бака
Б-Б
85°±30'
87°±30'
(4)
Линия, параллельная оси бака
(параллельно хорде крыла)
Линия, параллельная оси бака
(5)

Fig. 144. Installation of flanges on fuel tanks under the transmitters of the SBES-1447 fuel gauge: a) root tank; b) central tank; c) cantilever tank (top view to the right group of fuel tanks. For the left group - the reflected form).
KEY: (1) Axis of the aircraft; (2) (Conditionally turned 90°); (3) External contour of tank; (4) Line parallel to the axis of tank (parallel to wing chord); (5) Line parallel to the axis of tank.
Designation: НП = direction of flight

The transmitters of each group are connected together in series and together make up one resistor, which is reduced in proportion to the use of fuel in the group of fuel tanks (Fig. 145)

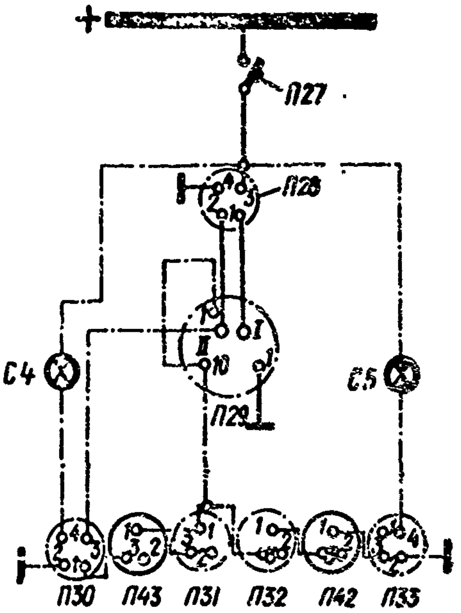
+
П27
П28
П29
С4
С5
П30
П43
П31
П32
П42
П33

Fig. 145. Electrical circuit of connection of transmitters of the SBES-1447 fuel gauge with indicator; S5 - fuel remainder warning light in the right tanks; P33 - the right root fuel gauge transmitter; P42 - the right central fuel gauge transmitter; P32 - the right cantilever transmitter of fuel gauge; P31 - the left cantilever fuel gauge transmitter; P43 - the left central fuel gauge transmitter; P30 - the left root fuel gauge transmitter; S4 - fuel remainder warning light in the left tanks; P29 - fuel gauge switch; P28 - fuel gauge indicator; P27 - AZS-5 of fuel gauge. Dot-dash lines show the invariable part of the circuit with replacement of fuel gauge. The section of the circuit between the transmitters, shown by the continuous line, is made by BPVL-0.75 wire.
Designations: С = S; П = P

The resistances of the potentiometers of the transmitters of each group are selected so that variation of their magnitude in proportion to the movement of the sliding contacts corresponds to the quantity of fuel in the group. With the aid of a switch the transmitters of each group of fuel tanks are switched on individually ("Left group", "Right group") or the transmitters of both groups are switched on ("Sum").

The indicator has a dual scale: the upper scale serves for reading the total quantity of fuel, and the lower - for determining the quantity of fuel in each group.

The main defects that are encountered in the operation of the fuel gauge are imprecise indications, which basically appear due to permanent deformations in the corrugated box and misalignment of the transmitting lever mechanism. This shows up especially on the fuel gauge installed on An-2 aircraft due to the low height of fuel tanks (sensitive transfer). For elimination of this defect a more frequent check of the fuel gauge reading is necessary with the aid of the monitor sensor.

Standardized TUE-48 Electrical Thermometer

The standardized electrical resistance thermometer is designed for remote measuring of the temperature of free air and air in the carburetor (on the first series of aircraft - for oil temperature measurement). The thermometer can measure temperature from -70 to +150°C.

The operating principle of the resistance thermometer is based on the property of electrical conductors to change their resistance depending on the ambient temperature.

The thermometer consists of transmitter and indicator. Transmitter is a nickel resistor included in the electrical bridge circuit. As the indicator serves a moving-coil logometer with two fixed gates.

The operation of the thermometer consists of the fact that with temperature change of transmitter there occurs redistribution of currents in the gates of the indicator logometer and the permanent magnet with pointer is installed along the resultant of the electromagnetic field of gates. The pointer on the scale shows the measured temperature.

The transmitter of free-air temperature is installed on the bracket of the left strut of the biplane cell, the air temperature transmitter in the carburetor - in the carburetor adapter.

The permissible instrument errors in the range from -40 to +130°C composes from ±5 to ±8°C. The error of the receiver - not more than 2°C.

The TTsT-13 Cylinder Head Thermometer

The thermoelectric thermometer of the cylinders serves for the temperature measurement of the cylinder heads. The operating principle is based on the property of the appearance of thermoelectromotive force during the heating of the joint of two heterogeneous metals. The magnitude of thermoelectromotive force depends on the material of conductors and the difference in the temperature of free cold ends and soldered heated ends. This phenomenon was discovered for the first time by Russian academician F. Epinus in 1756.

If we keep the temperature of the cold ends constant, then by the amount of thermoelectric force measured by the sensitive galvanometer, the temperature of the soldered ends can be judged. Such a method of temperature measurement is called thermoelectric, and the pair of metals, with the aid of which current, is obtained is called the thermocouple.

For measurement of the temperature of the cylinder heads a Chromel-Copel thermocouple is taken. The Chromel electrode is positive, Copel - negative. In connection with the fact that current appears very small (with temperature difference 300°C the thermoelectromotive force is equal to 20 millivolts), then it is very important that the cold ends not be located in the zone of elevated temperatures. For this they are diverted into the cabin with the aid of compensating leads made from this material. The instrument consists of a Chromel-Copel pair, which by one end is attached to the copper washer placed under the rear spark plug of the first cylinder, and the free cold ends are connected to the compensating leads, which in turn are connected to the indicator plug socket.

The indicator is a vibration resistant magneto-electric galvanometer with intragate permanent magnet. During heating of the cylinder head in the circuit there appears current, which will pass through the gate of the indicator galvanometer. As a result of the interaction of current passing in the gate, and the magnetic field of the permanent magnet the gate is turned together with the pointer. The pointer on the scale will show the temperature of the cylinder head.

The thermometer error appears as a result of the unequal temperature of the cold ends. This error is removed by a bimetallic thermocompensator, which will automatically move the pointer with temperature change of the cold ends. The influence of the ambient temperature on the electrical resistance of the gate of the galvanometer, wound from aluminium wire, is compensated by inclusion of a silite resistor into the electrical circuit, which is connected to one end of the gate. To the other end of the gate is connected a manganin added resistor.

Silite unlike aluminum has a negative temperature resistance factor, i.e., with an increase in temperature its electrical resistance is reduced and vice versa. Therefore, with change of temperature in the indicator the total resistance of the circuit remains unchanged. Consequently, the readings of the instrument will depend only upon the magnitude of electromotive force. On the latest aircraft (from the 172nd series) for monitoring the temperature of engine cylinder heads 1 and 9 the TTsT-13 thermometer has been replaced by the two-pointer 2TTsT-47 thermometer, which is distinguished from the TTsT-13 by the fact that in one housing there are mounted two indicators with their scales and pointers. The permissible errors of the instrument at ambient temperature +20°C are not more than ±8°C.

TE-45 Electrical Tachometer

The TE-45 electrical tachometer serves for measurement of the number of revolutions of the engine crankshaft during its operation. It consists of the transmitter and indicator and makes it possible to measure revolutions from 0 to 3500 per minute.

The indicator is a synchronous electric motor with a magneto-tachometric part. The transmitter is a three-phase alternating-current generator.

The transmitter consists of a bell-shaped permanent magnet, connected by a flexible roller with the engine camshaft connection and revolving with the same revolutions.

Inside the magnet is placed a three-phase stator, in which there appears three-phase alternating current with frequency equal to the revolutions of the magnet. This current along three wires enters the three-phase stator of the synchronous electric indicator motor. In the winding of the stator there appears a revolving electromagnetic field, which the rotor, which revolves with the speed of the generator magnet, absorbs.

On the end of the rotor is fastened a four-pole permanent magnet, placed inside the sensing element (copper cap). During rotation of the rotor with the magnet eddy currents will be created in the sensing element. The interaction of the revolving magnetic field and the eddy currents creates torque, proportional to the number of revolutions of the magnet, and consequently, the engine crankshaft. This torque forces the sensing element to revolve together with the large pointer, fastened on its axis. The rotation of the sensing element is limited by a spiral spring, which simultaneously returns the pointer to the initial position with decrease of revolutions and engine shut-off.

The large pointer is connected to a small pointer through four gears (with gear ratio 1:10). The permissible errors at revolutions 600-3000 per minute and temperature ±20°C comprise ±35 revolutions per minute; at temperature +50 and -60°C they comprise ±70 revoltuions per minute.

MV-16 Pressure and Vacuum Gauge

The pressure and vacuum gauge (Fig. 146) serves for measurement of absolute pressure of the air pressurization in the suction line of the engine after the supercharger. The instrument operates on the principle of a metal barometer with aneroid chamber.

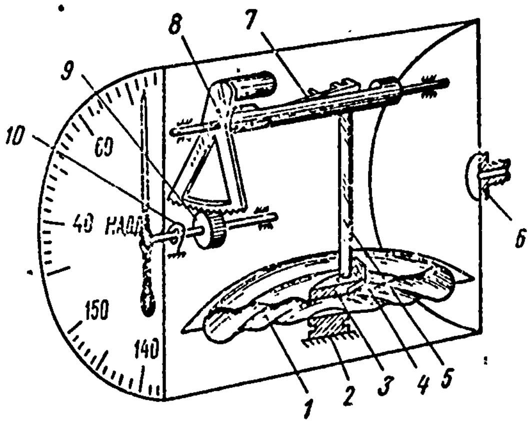

Fig. 146. MV-16 pressure and vacuum gauge: 1 - aneroid chamber; 2 - bottom center; 3 - top center; 4 - bimetallic roller; 5 - rod; 6 - connection; 7 - bimetallic plate; 8 - gear quadrant; 9 - gear; 10 - balance spring.

The sensing element is the aneroid chamber, placed in a sealed housing, connected by a tube with the suction line of the engine.

With change of pressure, created by the engine supercharger, the aneroid chamber is compressed or released. This deformation of the box through the transmitting mechanism is transferred to the pointer, which on the scale will show the boost pressure in millimeters of mercury column. At the engine shut-down the pressure in the suction line is equal to atmospheric, therefore the pressure and vacuum gauge should show the external atmospheric pressure.

The scale divisions are applied every 20 mm Hg, and the figures, indicating the amount of pressure, - in centimeters of mercury column. The measuring range is from 300 to 1600 mm Hg.

Defects of the instrument should include: disturbance of the sealing of the housing, connecting pipe, and also permanent deformations of the aneroid chamber. Permissible errors at normal temperature: at marks 300-700 and 1500-1600 mm Hg up to ±20 mm Hg and at marks from 800 to 1400 - up to ±10 mm Hg.

Flight and Navigation Instruments

VD-10 Altimeter

The VD-10 altimeter (Fig. 147) is designed for determining the flight altitude.

The following altitudes are distinguished: true - the flight altitude above a given terrain; absolute - the flight altitude above sea level; relative - the flight altitude above the takeoff or landing point.

The principle of operation of the altimeter is based on the measurement of atmospheric pressure. The method of barometric measurement of the altitude is based on the natural pressure loss with climb to altitude. Therefore the altimeter is constructively made in the form of a sensitive barometer, the elastic element of which is the unit of aneroid chambers, placed in the geometrical housing connected with the static wiring of the pitot-static tube. The aneroid chambers through the transmitting mechanism are connected to two pointers (large and small), placed on the face of the instrument.

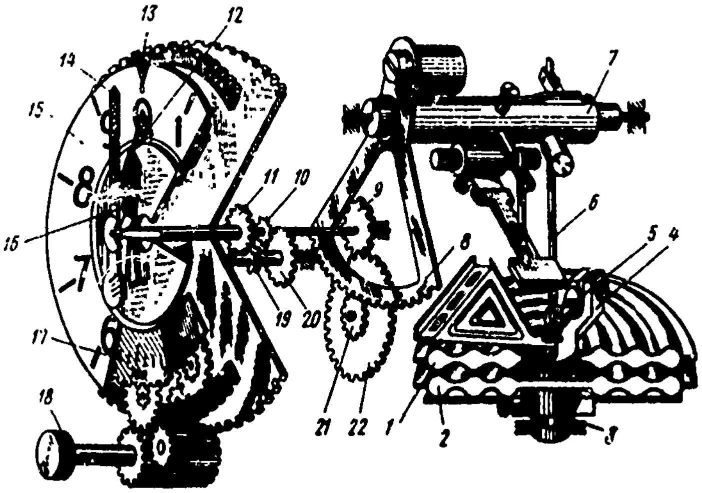

Fig. 147. VD-10 altimeter: 1, 2 - aneroid chambers; 3 - bottom center; 4 - top center; 5 - bimetal compensator; 6 - rod; 7 - axle of quadrant; 8 - gear quadrant; 9, 10, 19, 21, 22 - gears; 11 - gear of small pointer; 12, 13 - indexes; 14 - large pointer; 15 - scale; 16 - small pointer; 17 - scale of barometric pressure; 18 - knob.

The aneroid chambers and the transmitting mechanism with pointers can be rotated by the knob, by moving the pointer of the altimeter. Simultaneously when turning the knob the scale of barometric pressure and the two indexes rotate, indicating the altitude which corresponds to the barometric change relative to 760 mm Hg one - in meters, the other - in kilometers. The pressure scale makes it possible to introduce corrections to the altimeter readings, when pressure above the terrain being flown over does not match the pressure on the ground at the moment of flight.

The numbering of the scale is from 670 to 790 mm Hg in 10 mm Hg, graduation 1 mm Hg. The scale of the altitudes is up to 10 km, the graduation for the large pointer - 10 m, and for small - 100 m. Numbering from 0 to 9, which for the large pointer corresponds to the hundreds of meters, and for small - to thousands.

The operation of the altimeter consists of the fact that with climb to altitude the ambient pressure is reduced and the aneroid chambers are expanded. The movement of the center of chambers through gearing is transferred to the pointers, which, turning, show the altitude on the scale.

The altimeter has a series of significant errors, which force one to very thoroughly watch the altimeter and use it correctly.

The basic errors of the altimeter which affect the safety of flight are the following:

1. The error connected with the change in the atmospheric pressure near the ground. As is known, atmospheric pressure is unequal near the ground at various points of terrain, and flight will always occur over terrain with different pressure. Since the altimeter operates on the principle of measurement of atmospheric pressure, which is reduced with climb to altitude, then its readings in flight at the same altitude will be different. If, for example, the aircraft flys at the same altitude (with respect to the ground), but pressure along the route (near the ground) rises, then the pointers of the altimeter will continuously turn, showing decrease in altitude. If in this case we maintain the base altitude according to the altimeter, then flight will occur with climb, and actually the flight altitude will be higher (altimeter "undershows"). And vice versa, if along the route the pressure near the ground will drop, and in flight we hold the same altitude according to the altimeter, then flight will occur with descent (altimeter "overshows"). Such a phenomenon, in particular during flight outside ground visibility, can lead to severe consequences. In order to take this error into account, it is necessary to strictly observe a number of requirements, beginning with the moment of takeoff and to the landing itself:

a) before takeoff by turning the knob place the pointers to zero, with this the barometric scale will show the pressure near the ground, and indexes - altitude relative to pressure 760 mm Hg;

b) after takeoff during climb by turning the knob set one of the altimeters to pressure 760 mm Hg or set indexes to zero and using this altimeter climb to the base altitude (altitude of echelon). After climb to echelon altitude set the second altimeter to the echelon altitude. By this there is provided divergence of aircraft on collision courses at different altitudes;

c) during approach to the landing airfield request by radio the relative altitude (relative to sea level) of the landing place and on one of the altimeters set the index opposite this altitude, thereby correction is introduced analogically to the introduction of correction on the barometric scale. After permission is given to descend for landing, also set the second altimeter to this altitude.

2. Temperature error. In the examination of the first error the ground temperature was considered constant, but in reality the temperature change near the ground will redistribute the atmospheric pressure according to altitudes, which causes incorrect readings of the altimeter. Thus, with temperature increase near the ground the denser air layers rise upward, and the altimeter will "undershow" the altitude. On the contrary, with lowering of temperature near the ground the denser layers drop down, and the altimeter will "overshow" the altitude. Therefore, in the cold season it is necessary to be careful, in particular when breaking out of cloudiness.

3. Error with change of the terrain features. The altimeter does not consider the terrain features, therefore before flight it is necessary to study the route contour well or to study the route on a chart and always have a safe altitude over elevations.

Besides these basic errors, the altimeter has a number of instrument and adjustment errors, which are considered either in the construction of the altimeter, or directly by the pilot itself. The permissible altimeter errors (in m) with air temperature change are given in Table 17.

Table 17.

(1) Показание шкалы	(2) При температуре, °C			
	+20	+50	—45	—60
0	±15	±20	±20	±20
1000	±20	±25	±28	±30
2000	±35	±40	±45	±50
3000	±45	—	±65	±70
4000	±45	—	±65	±70

KEY: (1) Scale reading; (2) At temperature.

US-350 Speed Indicator

The US-350 speed indicator (Fig. 148) serves for determining the speed of the aircraft relative to the air. It operates on the principle of the measurement of dynamic head (dynamic pressure of air), which is equal to

$$\frac{\rho V^2}{2}.$$

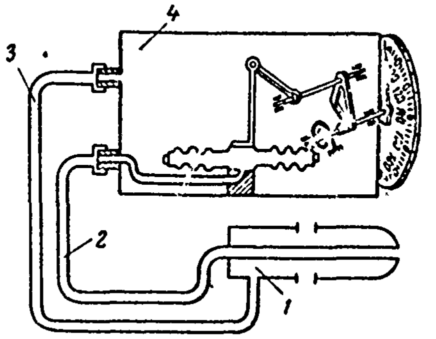

Fig. 148. US-350 speed indicator.

The speed indicator consists of: pitot-static tube (PVD) 1, meter 4 and connecting lines: dynamic 2 and static 3 pressures. The pitot-static tube has two chambers: front and lateral. The front chamber perceives total head (static and dynamic), the lateral chamber perceives only static pressure. The tube is fastened on the left strut between the upper and lower wing so that the head-on airflow would not be distorted by the action of the propeller and by vortices from the aircraft parts.

The pitot-static tube with the aid of dynamic and static lines is connected with a meter. Meter is a sensitive manometer, the bellow assembly of which is connected with the dynamic line of the PVD, and the sealed housing - with static. The bellow assembly through a transmitting mechanism is connected with the pointers. With increase in airspeed the dynamic pressure being perceived by the bellow assembly increases, which by expanding, through the transmitting mechanism will turn the pointers. The pointers on the scale show the airspeed. Deformation of the bellow assembly will occur only a little because of the dynamic pressure, since pressure - static - inside the sealed housing and inside the bellow assembly will be mutually balanced.

The speed indicator allows the following errors:

1. The speed indicator measures the dynamic pressure, which depends not only on the speed of the aircraft, but also the air density. The density depends on the temperature and pressure, which are changed both near the ground and at altitude. Therefore, dynamic pressure with the same flight speed will be changed with change of air density and the instrument readings will be incorrect. With climb the air density is reduced, dynamic pressure is reduced and the instrument will "undershow". This error is considered with the help of the navigation computer.

2. Instrumental errors are the same as for all diaphragm instruments, i.e., delay of readings, temperature and scale errors, stagnation.

3. Adjustment errors depend mainly on the installation of the pitot-static tube and line:

a) nonparallelism of the pitot-static tube with the incoming flow of air leads to incorrect readings of this instrument;

b) the vorticity of air in front of the aircraft components, to which the tube is attached, and also vortices directly near the PVD cause incorrect instrument readings;

c) the faulty sealing of wiring, bending, break, clogging of wiring, obstruction, clogging or freezing of the receiver lead to distorted readings or can cause complete failure of the instrument.

When using the speed indicator it is necessary to remember that due to the increased length of wiring, and also due to its bends the instrument is late in readings. In particular it is necessary to consider this during the transition of the aircraft from high speed to low.

Permissible errors at normal temperature at all graduations are not more than ±6 km/h. On the lastest aircraft there is installed PVD electric heating signalling.

VR-10 Rate-of-Climb Indicator

The rate-of-climb indicator VR-10 (Fig. 149) serves for determining the rate of climb and descent of the aircraft. The principle of operation of the rate-of-climb indicator is based on the measurement of the pressure differential of outside air at the given altitude and inside the container, connected with outside atmospheric air with the aid of a capillary. This pressure differential appears with vertical movement of the container, and its magnitude depends upon the speed of vertical movement.

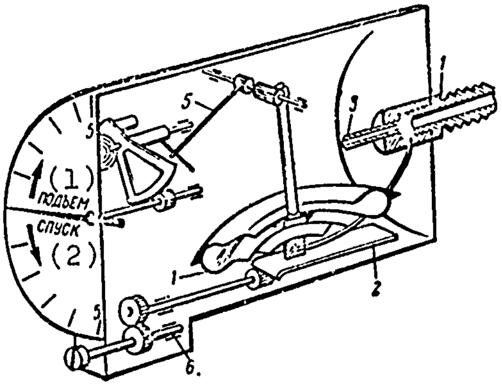

Fig. 149. VR-10 rate-of-climb indicator: 1 - manometric chamber; 2 - spring; 3 - capillary tube; 4 - fitting; 5 - transmitting mechanism; 6 - adjustment device. KEY: (1) Climb; (2) Descent.

The rate-of-climb indicator consists of a corrugated chamber connected with ambient air by a large-diameter tube. The chamber is enclosed in the sealed housing, connected with the environment by a capillary. Through the transmitting mechanism the chamber is connected to the pointer.

With climb of the aircraft the atmospheric air pressure is reduced. Air from the housing will exit through the capillary, due to which the air pressure inside the housing is greater than the atmospheric pressure inside the corrugated chamber, in which pressure is always equal to the ambient pressure. Under the pressure of this difference chamber will be compressed and through the transmitting mechanism will move the pointer upward from zero, showing the magnitude of the rate of climb in meters per second, since the pressure differential in the housing and chamber and, consequently, the amount of compression of the chamber depend on the speed of vertical movement.

With descent of the aircraft the atmospheric pressure inside the corrugated chamber increases, and inside the housing it remains at the magnitude proportional to the rate of descent. Under the action of the difference in pressures the corrugated chamber is expanded and through the transmitting mechanism it moves the pointer down from zero, showing the rate of descent in meters per second.

The rate-of-climb indicator allows the following errors:

1. With level-out of the aircraft into horizontal flight the rate-of-climb indicator will not show horizontal flight until pressures in the corrugated chamber and inside housing are equal, i.e., the rate-of-climb indicator is late in readings. The sharper the transition to horizontal flight is accomplished, the longer the delay will be. It is especially important to consider this error when using the rate-of-climb indicator in flight with the ground not visible.

2. The air density affects the difference between pressure inside the corrugated chamber and inside the housing. For instance,

at reduced air density the pressure differential will be less, since air will pass faster through the capillary and the instrument will "undershow."

3. Instrument errors are the same as for all diaphragm instruments.

Of the defects, which appear in operation, one should note clogging or breakage of the capillary, clogging of the tube which connects the corrugated chamber with the atmosphere, the disturbance of the sealing of the instrument, permanent deformations of the corrugated chamber (pointer does not set to zero when the aircraft is parked). In order to set the pointer on 0, there is a special adjusting screw, which it is necessary to unscrew, pull out and having turned it, bring the pointer to 0.

The instrument error at normal temperature at marks from 1 to 10 meters per second should not exceed +1 meter per second. [Translator's note: appeared in Cyrillic as ∔.]

KI-12 Compass

The KI-12 compass is used on the aircraft as a duplicating instrument. The principle of operation of the compass is based on the interaction of the insulated magnetic pointer with terrestrial magnetism.

In a plastic housing with the aid of a nut there is fastened a bushing with a step bearing rolled into it. The bushing serves as a bearing for the column. The vertical movement of the column is limited by a spring washer, locking the column underneath. On the step bearing rests a core, pressed to the bushing of the compass card. On the column the bushing is locked by a snap ring, protecting the compass card from coming off during revolution of the compass.

The scale graduation of the compass card is 5°, numbering every 30°. The two main compass points are marked by the letters N and S. The extended scale graduations are coated with an illuminating substance, short graduations - white.

On the bushing are beaded the magnet holders, which are parallel to the N-S line of the scale. The face of the instrument is covered with glass, there a drift bar is installed, coated with an illuminating substance. In the bushing of the compass card and column rests a shock-absorbing spring. The housing of the compass is filled with ligroin LS-213. The change in the volume of liquid is compensated by a diaphragm, screwed into the housing.

In the top of the housing there is mounted a compensator, which consists of two longitudinal and two transverse rollers, into which magnets are pressed. The rollers through a gear drive are rotated by two extenders, brought out to the face of the instrument (above) into special openings in the cover, which are shut by a plug. Near the openings in the cover are designations N-S and E-W. The neutral position of the magnets of the compensator is determined by the matching of the point marks of the cover and extenders.

On the face side into the cover is screwed a socket with a light for individual illumination. Light from the light falls through the slot in the housing on the face of the sight glass, is dispersed and illuminates the scale.

The compass allows a number of errors:

1. Magnetic declination - the angle between the northern direction of true and magnetic meridians. This error is considered with the aid of magnetic declination charts.

2. Deviation - the angle between the northern direction of the magnetic and compass meridians. The deflection of the compass card from the magnetic meridian occurs because of the action of the magnetic field of the aircraft on it, created by magnets, steel parts, which are located on the aircraft. They distinguished the deviation obtained from the permanent magnetic field of the aircraft (semicircular), and deviation obtained from the alternating magnetic field of the aircraft (quadrantal). Semicircular deviation is eliminated by the compensator, and quadrantal is listed in the chart. By the compensator it is possible to remove deviation up to 70°.

3. Turning compass deviation (northern turning error) is obtained during turns because of the action of centrifugal forces on the loaded southern pointer tip. The loading of the southern pointer tip is caused by balancing of the magnetic banking of the northern pointer tip. Northern turning error is considered: during turns on northern courses by underturn by the amount of bank, and on southern courses - by overturn to the amount of bank.

4. Acceleration error - the action of forces of inertia on the loaded end with change of speed on eastern and western courses.

5. Heeling error, which is obtained because of banking of the vertical component of the magnetic field of the aircraft, which affects the compass card during aircraft banks.

6. Vibration of the compass card.

7. Stagnation.

8. Deviation from vibrations.

9. Absorption of the compass card by liquid during turns. The compass operates normally with bank up to 17°. The time of complete damping of the compass card is 17 s.

On aircraft of the latest series a KI-13 compass is installed.

AGK-47B Gyrohorizon

The AGK-47B gyrohorizon - combined, electrical, consists of three instruments mounted in one housing: gyrohorizon, turn indicator and slip indicator. The gyrohorizon serves for determining the position of the aircraft relative to the horizon. The operating principle is based on the property of the principal axes of the free gyroscope to keep a constant prescribed position in space.

The sensing element of the gyrohorizon is a gyroscope with vertical arrangement of the principal axis. The axis of rotation of the rotor is inclined forward in the direction of flight at an angle of 2° for decrease of errors during turns. The gyroscopic unit of the gyrohorizon consists of a gyromotor, which is a three-phase asynchronous a.c. electric motor, which revolves at the rate of 20,000-22,000 revolutions per minute. The gyromotor is fed with three-phase alternating current with voltage 36 V with frequency 400 Hz.

The rotor of the gyromotor is assembled from plates of electrical steel and has a "squirrel cage," cast from aluminum alloy. The rotor revolves outside the stator for increase of gyroscopic moment. The packet of the stator is also assembled from electrical steel, in 12 grooves of which is placed a three-phase double-pole winding, connected by a spider. The gyromotor is placed in the housing, which is simultaneously the inner frame of the gimbal suspension. The inner frame of the gimbal suspension is mounted on two bearings in the external frame. The external frame of the gimbal suspension on two bearings is mounted in the housing. The axis of rotation of the external frame of the gimbal suspension is arranged parallel to the lateral axis of the aircraft, the axis of the internal frame is parallel to the longitudinal axis of the aircraft.

On the face of the external frame there are attached the pitching and side banking scales. On the Cardan joint there is attached the aircraft silhouette, and the index of the skyline is connected with the housing of the instrument and by a knob can be raised or lowered. Thus, for convenience of maintaining the condition of flight (horizontal flight, climb, gliding) it is possible to match the index of the skyline with the aircraft silhouette. In order to return the principal axis of the gyroscope to the vertical position in the case of its deviation as a result of friction in the axes or imbalance of the gyroscope, there is a correcting device (Fig. 150a), which consists of the sensitive and the power part.

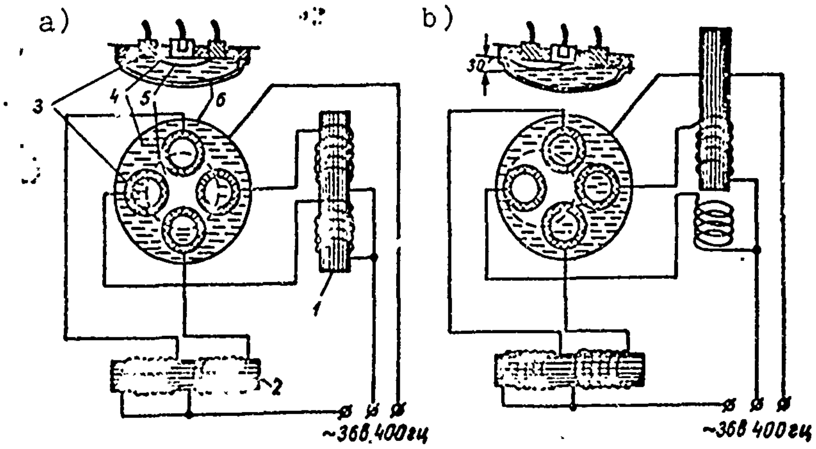

Fig. 150. Schematic diagram of the correcting device of gyrohorizon: 1 - solenoid of longitudinal correction; 2 - solenoid of lateral correction; 3 - contacts of the switch; 4 - current-conducting fluid; 5 - boundary of the fluid meniscus; 6 - copper container of switch. Designation: гц = Hz

The sensitive part is the fluid switch, mounted in the bottom part of the housing of the gyromotor rotor. The power part is made in the form of two solenoids - longitudinal and lateral, fastened on the upper part of the housing of the gyromotor rotor.

The fluid switch is made in the form of a copper container filled with current-conducting fluid. The upper part of the vessel is made from insulating material. Into it are pressed four copper contacts. The inner cavity of the switch is filled up with current-conducting fluid so that a small air gap remains.

Each solenoid consists of a core and two windings, arranged one on each side of the center of gravity of the core. The core can be moved along the windings. To the solenoid windings is supplied current. Each solenoid winding is electrically connected with one of the contacts of the switch (longitudinal contacts - with lateral solenoid, lateral - with longitudinal).

With deviation of the principal axis of the gyroscope from the vertical position there will occur inclination of the switch relative to the horizonal plane (Fig. 150b). One of the contacts will leave the fluid and, consequently, current will not go to the solenoid winding, which is connected with this contact. The solenoid core will move toward the winding, along which current passes. The moment from the weight of the solenoid core will cause precession of the gyroscope, under the action of which the principal axis of the gyroscope will stop in the vertical position. After this the contact, which left the fluid, will again be in the fluid, which will give the possibility of feeding current to the solenoid winding and of placing the core along the axis of symmetry. The moment from the weight of the core disappears, and precession is ceased.

The exit of some contact from the fluid and, consequently, the activation of the correcting device occur with deviation of the principal axis of the gyroscope from vertical position by 0.5°.

In the gyrohorizon there is a caging device, serving for rapid restoration of the principal axis of the gyroscope to the vertical position with its large slopes, and also for preventing damage during transportation. The caging device consists of three cams, pushers, latch, cage, operating and return springs and a signal blinker, made in the form of a red flag with the inscription "Cage."

When caging the gyrohorizon it is necessary to pull the caging knob completely "Back," at this moment on the face of the instrument appears the flag "Gage." When uncaging push the caging knob "Forward." With a nonoperating gyromotor the gyrohorizon should always be caged.

Turn Indicator

The turn indicator (Fig. 151) is constructively designed as a separate instrument. It is fastened to the rear flange of the housing of the gyrohorizon and serves for determining the rotation of the aircraft around the vertical axis.

Fig. 151. Turn indicator: 1 - gyromotor; 2 - current leads; 3 - damper lever; 4 - air damper; 5 - pointer; 6 - frame; 7 - stops; 8 - regulating lever; 9 - spring which balances the gyroscopic moment.

It operates on the property of a restrained gyroscope to precess with the application of force to the principal axis. The principal axis of the gyroscope is arranged parallel to the longitudinal axis of the aircraft.

The rotor of the gyroscope is the gyromotor, which just as the gyromotor of the gyrohorizon is fed from PAG-1F converter. The gyroscopic moment of the gyroscope, which appears with turn of the aircraft around the vertical axis, is transferred to the pointer, which comes out to the face of the instrument and is deflected in the direction of the turn. For damping the oscillations of the system there is placed an air damper (the same as in pneumatic turn indicator).

The deflection of the pointer is limited by a spiral spring, which simultaneously after cessation of the turn returns the pointer to the neutral position.

The slip indicator serves for determining slip in straight flight and during turns. It operates on the principle of a free-hanging pendulum.

By the slip indicator, the turn indicator and the gyrohorizon it is possible to sufficiently accurately judge the position of the aircraft in the air, execute coordinated turns, which is necessary in flight outside ground visibility.

The PAG-1F is intended for supply of one or two AKG-47B electrical gyrohorizons with alternating three-phase current with voltage 36 V and frequency 400 Hz. It is the unit which consists of a direct-current electric motor with compound excitation and a three-phase a.c. generator, excitable by the permanent magnet of the rotor. For elimination of interference to radio reception the PAG-1F has a special filter. During operation on one instrument the PAG-1F requires current not more than 3 A, during operation on two instruments - not more than 3.5 A.

GPK-48 Electrical Directional Gyrocompass

The GPK-48 electricial directional gyrocompass is designed for holding the predetermined course of the aircraft and executing turns to the prescribed number of degrees. The operating principle of the instrument is based on the property of the principal axis of the free gyroscope to maintain the given position constant in space.

The sensing head of the directional gyrocompass is a gyroscope with horizontal arrangement of the principal axis. The gyro unit is an electrical gyromotor, enclosed in a housing, which is the inner frame of the gimball suspension.

The gyromotor is an asynchronous electric motor which operates from a power source of alternating three-phase current with voltage 36 V with frequency 400 Hz. The rotor of the gyromotor is located outside the stator for increase in the gyroscopic moment and is made in the form of a brass flywheel, inside which is located the "squirrel cage." The rotor develops 21,000-23,000 revolutions per minute.

The external (vertical) frame of the gimbal suspension has an unlimited angle of rotation around the vertical axis. In the upper part of the vertical frame there is mounted a compass card with 1° graduation and numbering every 10°. In the bottom part of the instrument there is mounted the caging mechanism, with the help of which the gimbal suspension is locked. In order to set the compass card to the prescribed course, it is necessary to push the caging knob in as far as it will go and then, rotating the knob, bring the necessary graduation of the compass card under the drift bar on the face of the instrument, after which by pulling the caging knob back free the gyroscope and maintain the prescribed course.

For determining the position of the gage a blinker is provided in the instrument. When caging on the face of the instrument there appears a red circle, when uncaging this circle disappears.

Errors of the directional gyrocompass appear as a result of friction in the axes and the twenty-four hour revolution of the earth. This leads to rotation of the gyroscope around the vertical and horizontal axes. Deviation of the gyroscope around the vertical axis in the directional gyrocompass occurs 2-3° during 10-15 min, which is corrected by hand with the caging device after checking the course by the magnetic compass or radio compass.

In order to eliminate deviation of the gyroscope around the horizontal axis in the directional gyrocompass, special horizontal correction is used. The sensitive controlling element of horizontal correction is a switch, pressed to the axis of the housing of the gyromotor. The switch is a commutator with two contact half-rings. To one of the half rings is fed the phase of alternating current, which feeds the instrument. The other ring is switched off. To the vertical (external) frame is attached a pressed plate with brushes, insulated from one another and from the frame, and touching the commutator plates. These brushes are connected with two control windings of the corrector motor, which is the power element of correction.

The corrector motor is a two-phase multipolar reversible induction motor, which operates in the short-circuiting mode (hindered mode). The corrector motor is located in the upper part of the instrument. The rotor of the corrector motor is rigidly attached on the upper part of the vertical frame of the Cardan joint. In the grooves of the rotor packet there are placed three windings: one main and two control. The control windings are placed in the same grooves, but have different direction of winding. The reversing of the correction moment is accomplished by turning on one control winding or another. The stator of the corrector motor is rigidly connected with the instrument housing cover and is a packet of chips of electrical steel, filled with aluminum alloy ("squirrel wheel").

The correction operation occurs in the following manner: when the axis of the gyromotor is perpendicular to the axis of the vertical frame, both brushes touch the turned-off ring of the switch, the electric circuits of the control windings are opened. The pulsed magnetic field of current of the main winding does not create correcting moment.

With disturbance of the perpendicularity by more than 4° the half-ring of the commutator, to which the current is fed, closes one of the brushes and activates the circuit of one of the control windings. Because of the shift in space and in phase (in time) between the currents of the main and closed-coil control windings there is formed a rotating magnetic field, which in this case intersects the "squirrel cages" of the stator and brings currents in them. As a result of the interaction of the magnetic field of the rotor and currents of the stator there is created torque, which causes the precession motion of the gyroscope and restores the principal axis to the horizontal position with respect to the vertical frame.

Warnings. 1. When setting the compass card to the prescribed course the caging knob must be turned slowly and smoothly, in order not to cause a large gyroscopic moment, which can damage the ball bearings and unbalance the instrument.

2. During takeoff and landing the instrument should be uncaged.

3. The instrument can be used 5-6 min after turning on the circuit breaker.

PDK-45 Telecompass with Potentiometer Tap

In connection with the fact that on the aircraft in the cockpit and near it there are many ferromagnetic masses, electrical instruments, and radio equipment, which create a magnetic field inconstant in magnitude and direction, variable magnetic compass deviation is created, not being computable. This led to the application of the distant-reading compass, whose transmitter - magnetic compass leads out of the cabin into the tail, wing, and its readings are electrically transmitted to the indicator installed on the instrument panel.

The telecompass with potentiometer tap consists of transmitter and indicator. The transmitter is a magnetic compass, installed in the tail section of the fuselage behind frame No. 15. The indicator is a three-frame logometer with a movable magnet (Fig. 152).

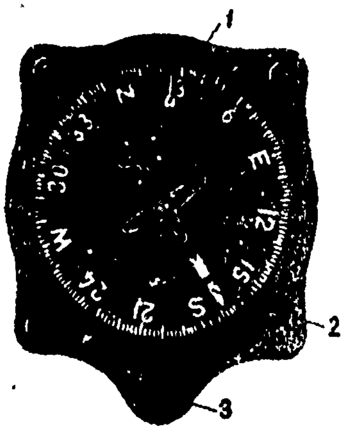

Fig. 152. PDK-45 indicator: 1 - course marker; 2 - pointer with small aircraft silhouette; 3 - knob.

The operating principle of the telecompass with potentiometer tap is based on the property of the magnetic system of the transmitter to be set in the plane of magnetic meridian. The readings of the magnetic transmitter are electrically transmitted to the indicator.

To the magnetic system of the transmitter are rigidly connected three brushes, arranged at a 120° angle to each other. The brushes slide along the annular potentiometer, mounted on the housing of the compass. To two diametrically opposite points of the annular potentiometer current is supplied from the aircraft electrical wiring system. The potentiometer changes its position with change of the aircraft course. The difference of potentials, being removed by brushes from the potentiometer, depends upon the position of the brush with respect to the points of current supply. Each position of the brush on the potentiometer strictly corresponds to one fully determined magnetic course of the aircraft. The voltage, being removed by brushes from the potentiometer, along three conductors is supplied to three fixed frames (windings) of the logometer of the indicator, arranged at 120° to each other.

The permanent magnet placed inside the windings is installed with respect to the resultant of the electromagnetic field of frames. On the axis of the magnet is installed a disk with a small aircraft silhouette, which on the scale connected with the windings will show the aircraft course. The annular potentiometer with change in the aircraft course turns together with the aircraft. The position of the brush with respect to the current supply points is changed, consequently, the currents which flow through the windings of the logometer are changed. The resultant of the electromagnetic field of frames is deflected, turning the permanent magnet together with the small aircraft silhouette and setting in the other direction. The small aircraft silhouette on the scale will show the changed magnetic course of the aircraft (Figs. 153 and 154).

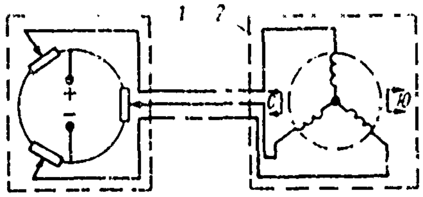

Fig. 153. Schematic diagram of telecompass with potentiometer tap: 1 - transmitter; 2 - indicator.

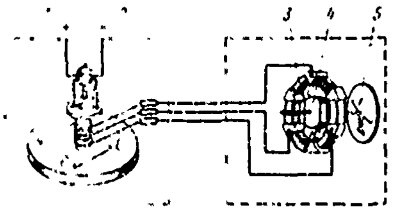

Fig. 154. Electrokinematic diagram of telecompass with potentiometer tap: 1 - brush; 2 - annular potentiometer; 3 - stator winding; 4 - rotor magnet; 5 - disk with small aircraft silhouette.

The scale graduation is 2°, numbering every 30°. The scale together with windings can be turned by the knob located on the face of the instrument. For convenience of maintaining the aircraft on the prescribed course we rotate the knob and place the prescribed course of the scale under the upper fixed index. Then with approach of the aircraft to the prescribed course the small aircraft silhouette will be arranged in the direction of flight. This facilitates maintaining the aircraft course.

The PKD-45 transmitter is a perfected magnetic compass, whose magnetic system consists of four magnets, located inside a hollow compass card, having the possibility of freely rotating around the vertical axis.

On this axis is mounted a plate with three brushes, sliding along the potentiometer, and three slip rings, with the aid of which voltages are removed from the moving brushes. The compass card is located in the bowl, filled with ligroin for reduction of the pressure of the compass card on supports and for damping. The annular potentiometer is located above the compass card and is mounted on a special bridge, rigidly connected with the bowl.

For compensation of the change of the volume of ligroin from the temperature there is a bellows, attached on the cover of the bowl. The bellows is covered with a plastic cap. On the upper part of the compass card there is a scale, divided into 360°, which is evident through the inspection window with the course graduation mark. On the cap of the bowl near the inspection window there is a pointer and the inscription "Direction of flight," which helps to correctly set the transmitter during installation. The pointer and·the drift bar lie on one straight line, passing through the center of the transmitter. The bowl is placed in a binnacle with the gimbal suspension, the external ring of which is hung in the binnacle with the aid of shock-absorbing springs. The binnacle has four lugs with holes for bolting on the aircraft. On the cover of the binnacle are located four seats, arranged 90°, in them are placed cylindrical cases with compensating magnets for decrease of deviation.

On the side of the transmitter there are two plug-type connectors. To the three-pole plug-type connector there are connected transmitters, to the double-pole - voltage from the aircraft electrical wiring system. The connecting wires from the plug-type connectors to the potentiometer and brushes pass through the hollow pins of the gimbal suspension.

So that it would be possible to turn the compass in some direction relative to the binnacle, during installation of the compass on the aircraft for the elimination of mounting error there is provided a clamping ring with screw, hung on the binnacle on shock-absorbing springs.

The indicator is a three-frame logometer with movable magnet. The role of the frames is carried out by three pairs of windings, arranged at 120° angle, which are placed in a movable base, connected through a pinion drive with the knob, protruding from the face of the instrument. To the movable base is fastened the scale, divided into 360°.

The leads from the windings are soldered to three rings of the commutator, along which slide three brushes. Each brush is soldered to the yoke of the plug-type connector. Inside the windings there is placed a permanent magnet, hafted to a shaft, which can freely turn in bearings, on the end of the shaft is attached a pointer with small aircraft silhouette.

With passage of current through the windings of the logometer of the indicator the permanent magnet will be set with respect to the resultant of the electromagnetic field of the windings and the pointer, connected with the magnet, will indicate the course of the aircraft on the scale.

For the convenience of execution of turns when constructing a "box" using the instrument-landing system on the instrument dial every 90° there are placed indexes.

The PDK-45 deviation is removed by means of inserting magnets into the seats of the cylindrical cases located on the binnacle. The magnets have different coloring of the north pole, which characterizes its magnetic force.

With the stacking of two red magnets in the seats of two diametrically opposite cylindrical cases (one magnet in each cylindrical case), deviation will change in some direction (depending on which side the magnet is placed in the cylindrical case) 4-5°, the pair of magnets with yellow color of the north pole will change deviation 2-2.5° and with green color of the north pole - 1°. With stacking of the magnet in one cylindrical case it is mandatory to stack the magnet with the same color and in the opposite cylindrical case. Two diametrically arranged cylindrical cases serve for elimination of deviations on N-S courses, the two other diametrically opposite cylindrical cases for the elimination of deviation on E-W courses.

In connection with the fact that the transmitter is installed in the tail section of the fuselage, the influence of the magnetic field of the aircraft on the transmitter will be insignificant, and deviation usually does not exceed 1-2°. Therefore, in practice it is not removed, but written down.

GIK-1 Gyro Induction Compass

The (GIK-1) [ГИК-1] gyro induction compass (Fig. 155) serves for the determination of the magnetic heading of aircraft, the execution of turns by an assigned number of degrees, and in combination with the (ARK-5) [АРК-5] radio compass – the magnetic bearing and course angles of a radio station which are necessary for calculation of landing approach in the (OSP) [ОСП] system [OSP – instrument landing equipment]. The GIK-1 is distinguished from other compasses by pinpoint accuracy, by an independence of readings from flight conditions, and by the almost complete absence of deviations.

The gyro induction compass consists of the ID induction pickup 6, the G-3M gyro unit 8, KM correction mechanism 2, U-6M amplifier 7, UGR-1 indicator 3, UGK-2 indicator 4, the VK-53RB correction switch, the SK-11 terminal box 1, and the 5-K alignment knob 5.

The ID induction pickup serves for the magnetic course correction of readings taken from the gyro unit.

The G-3M gyro unit is intended for averaging the readings of the magnetic course which were taken from the induction pickup, and for the precise execution of turns by an assigned number of degrees.

Fig. 155. The complete set of the GIK-1 compass.

The KM correction mechanism is intended for connection between the induction course pickup and the gyro unit, and also for the elimination of quadrant deviation and systematic and instrument errors of the system.

The U-6M amplifier fulfills the following functions:

it strengthens the signal of the alternating current of double frequency which enters from the induction pickup through the autosyn of the correction mechanism, converts this signal into the alternating current of the main portion (frequency of power source), strengthens the transformed signal, and feeds it to the controlling winding of the DID-0.5 processing motor of the follow-up system of the correction mechanism;

it converts the direct current which enters from the current outlets of the potentiometer of the correction mechanism into a signal of alternating current, strengthens it, and feeds it to the controlling winding of the DID-0.5 processing motor of the follow-up system of the gyro unit;

it transforms the signal of direct current which enters from the current outlets of the potentiometer of the indicator into a signal of alternating current, strengthens it, and feeds it to the controlling winding of the DID-0.5 processing motor of the follow-up system of the indicator.

The UGR-1 indicator shows all parameters, for the determination of which the GIK-1 compass is intended, i.e., magnetic heading, and is also intended for the execution of turns by an assigned number of degrees.

The UGK-2 indicator shows the magnetic course of the aircraft and serves for the execution of turns by an assigned number of degrees.

The VK-53RB correction switch is intended for the automatic disconnecting of azimuthal correction and correction of the horizontal position of the axis of the gyrorotor during turning of the aircraft at an angular velocity greater than 0.1-0.3°/s for averting the misalignment of the follow-up system and appearance of errors during turns.

The SK-11 terminal box is intended for the electrical connection between units of the gyro induction compass.

The 5-K alignment knob serves for the rapid alignment of the indicator readings which correspond to the position of the induction pickup relative to the magnetic meridian after switching on of the compass.

Basic technical data for the GIK-1

Readiness of compass for operation after switching on, min:

at an ambient temperature from +20 to +50°C not more than 1

at an ambient temperature of -60°C not more than 3

Error of compass during the determination of magnetic heading, degrees:

at standard atmosphere no more than ±1.5

at an ambient temperature of +50 and -60°C not more than ±2

Additional post-turn error of compass for every minute of turn, degrees not more than 0.5

Error in the readings of the magnetic bearing of the radio degrees not more than ±3.5

Operating altitute of compass, m........20,000

Necessary power supply:

direct current (voltage), V......... 27±2.7

alternating current:

voltage, V from 33.9 to 39.6

frequency, Hz.......400±8

Weight of complete set (without UGK-2), kg not more than 10.5.

Operating principles. The GIK-1 compass operates on the property of a gyroscope with three degrees of freedom — to preserve the horizontally arranged axis of the rotor in an assigned azimuth and the property of the sensing head of the induction pickup to determine its position relative to the magnetic meridian.

Figure 156 depicts the frame diagram of the GIK-1.

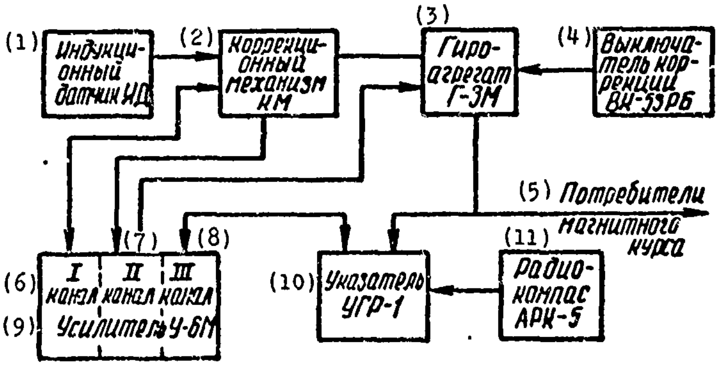
(1) Индукционный датчик ИД
(2) Коррекционный механизм КМ
(3) Гироагрегат Г-3М
(4) Выключатель коррекции ВК-53РБ
(5) Потребители магнитного курса
(6) I канал
(7) II канал
(8) III канал
(9) Усилитель У-6М
(10) Указатель УГР-1
(11) Радиокомпас АРК-5

Fig. 156. The frame diagram of the GIK-1 compass.

KEY: (1) Induction pickup ID; (2) Correction mechanism KM; (3) Gyro unit G-3M; (4) Correction switch VK-53RB; (5) Users of magnetic course; (6) Channel I; (7) Channel II; (8) Channel III; (9) Amplifier V-6M; (10) Indicator UGR-1; (11) Radio compass ARK-5.

The gyro unit, which is the gyroscopic course selector, is connected by a remote potentiometric gear with the indicator, as a result of which the position of the aircraft in azimuth or the deviation of the aircraft from assigned course is transferred to the indicator.

The errors of compass induced by the deviation of the gyroscope around the vertical axis because of friction in the shaft and the twenty-four hour rotation of the earth are eliminated automatically by the magnetic pickup which is connected remotely through the correction mechanism to the gyro unit (azimuthal correction).

During turns of the aircraft the azimuthal correction is automatically disconnected by the VK-53RB correction switch to avoid errors connected with the non-horizontal position of the sensing head of the induction pickup. For this purpose during turns the correction of the rotor of the gyro unit is disconnected. This retains the axis of the rotor in a horizontal position.

The GIK-1 compass has three follow-up systems. The first follow-up system connects the induction pickup with the correction mechanism; the second – the correction mechanism with the gyro unit, and the third – the gyro unit with the indicator. Each follow-up system has its own channel of amplification and a follow-up drive which consists of the DID-0.5 electric motor and a reduction gear. All three channels are united in one amplifier. The dual indicator consists of two systems, one of which shows the magnetic course, and the other, connected by a remote selsyn gear with the frame of the ARK radio compass, the magnetic bearing and course angles of the radio station.

The induction pickup installed in the left cantilever of the lower wing (for reducing the influence of the magnetic field of the aircraft) serves for correction of magnetic course of the readings of the gyro unit. The sensing head of the induction pickup consists of three magnetic probes arranged on the sides of an equilateral triangle. Each magnetic probe (Fig. 157) has two parallel permalloy cores 1 with high magnetic permeability which have been placed inside the magnetization windings 2. Both cores together with the magnetization windings are placed inside signal winding 3. The magnetic probes are mounted on a plastic platform. The magnetization windings are connected in series, and signal – by a triangle. The platform with the magnetic probes and float is fastened with the help of cardan rings to the pickup housing. The pickup housing is filled with a fluid which consists of 75% of ligroin and 20% MVP oil. A gimbal suspension ensures the horizontal position of the sensing head of the pickup during banks of the aircraft to any side at an angle up to 17°.

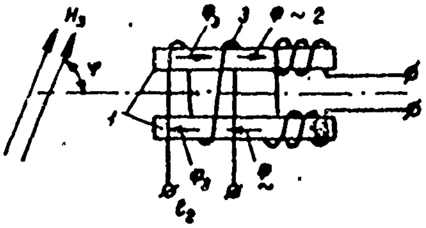

Fig. 157. The arrangement of the magnetic probe of the pickup.

On the cover of the pickup above is mounted a deviational device which consists of two transverse and four longitudinal rollers with pinions for the transfer of rotation. In two transverse and two longitudinal rollers magnets are placed. The two extreme longitudinal rollers are oblong and have slotted shafts.

The operation of the induction pickup consists of the following. The terrestrial magnetic field creates in the permalloy rods of the pickup a magnetic flux Φ_3, the magnitude of which will depend on the position of the rods relative to the vector of the terrestrial magnetic field H_3 and the permeability of the permalloy. The constant magnetic flux created by the magnetic field of the earth in rods as a result of a change in their permeability is converted into pulsing, which leads to the creation of electromotive force in the signal windings according to the law of electromagnetic induction. The magnitude of electromotive force in the signal windings will depend on the position of the rods relative to the terrestrial magnetic field and, therefore, on the position of the induction pickup, connected with the aircraft, with respect to the magnetic meridian. The greatest emf value in signal winding will be when its rods are arranged parallel to the magnetic meridian. In proportion to the deviation of the rods from the magnetic meridian the emf will be reduced, and when the rods become perpendicular to the meridian the emf in the signal winding will disappear because the magnetic lines of force will not intersect its turns.

The change in magnetic permeability in the rods occurs as a result of the transmission of alternating current on the magnetizing windings, which leads to the periodic magnetization of the cores. For the maximum value of current the cores are magnetized to saturation and magnetic permeability, and correspondingly also magnetic flux Φ_3 in them from the magnetic field of the earth is reduced. With the reduction in exciting current and its passage through zero value magnetic permeability increases and it reaches a maximum. Correspondingly the magnetic flux Φ_3 becomes maximum. Thus in the cores a pulsing magnetic flux is formed which has a double frequency as compared with the frequency of the alternating current which feeds the magnetizing windings, current being removed from the winding of the rotor enters the first channel of the amplifier, where it is amplified, is converted into the alternating current of the frequency of power source, is again amplified, whereupon it is directed to the controlling winding of the DID-0.5 motor of the follow-up system of the correction mechanism. The electric motor D rotates the rotor of the autosyn through the reduction gear until the axis of the rotor poles is established perpendicular to the resultant of the electromagnetic field of the stator. The emf in the winding will be equal to zero, the electric motor will stop, and the pointer will indicate the course of the aircraft.

With a change in the course of aircraft the pickup changes its position relative to magnetic meridian, there is a redistribution of coil currents in the stator of the autosyn, and the electric motor turns the rotor of the autosyn to the same angle as the pickup.

Figure 159 depicts the fundamental electromagnetic circuit of the GIK-1 compass. On the vertical shaft of the outer frame of the gyroscope of the G-3M gyro unit an annular potentiometer 10 is fixed. To two diametrically opposite points of the annular potentiometer through slip rings 9, attached on the shaft, and brushes 8, connected with the housing, a direct current of 27 V is moved from the aircraft wiring system. The current is taken from the annular potentiometer by three brushes arranged at an angle of 120° on the gear of reduction gear 11. During the operation of the master electric motor 6 through reduction gear 7 gear 11 together with the brushes will be turned, and the brushes, sliding on the annular potentiometer, will change their position relative to the contact electrodes. The brushes of the potentiometer of the gyro unit are connected through slip rings by three wires with the brushes of the potentiometer 19 of the KM correction mechanism.

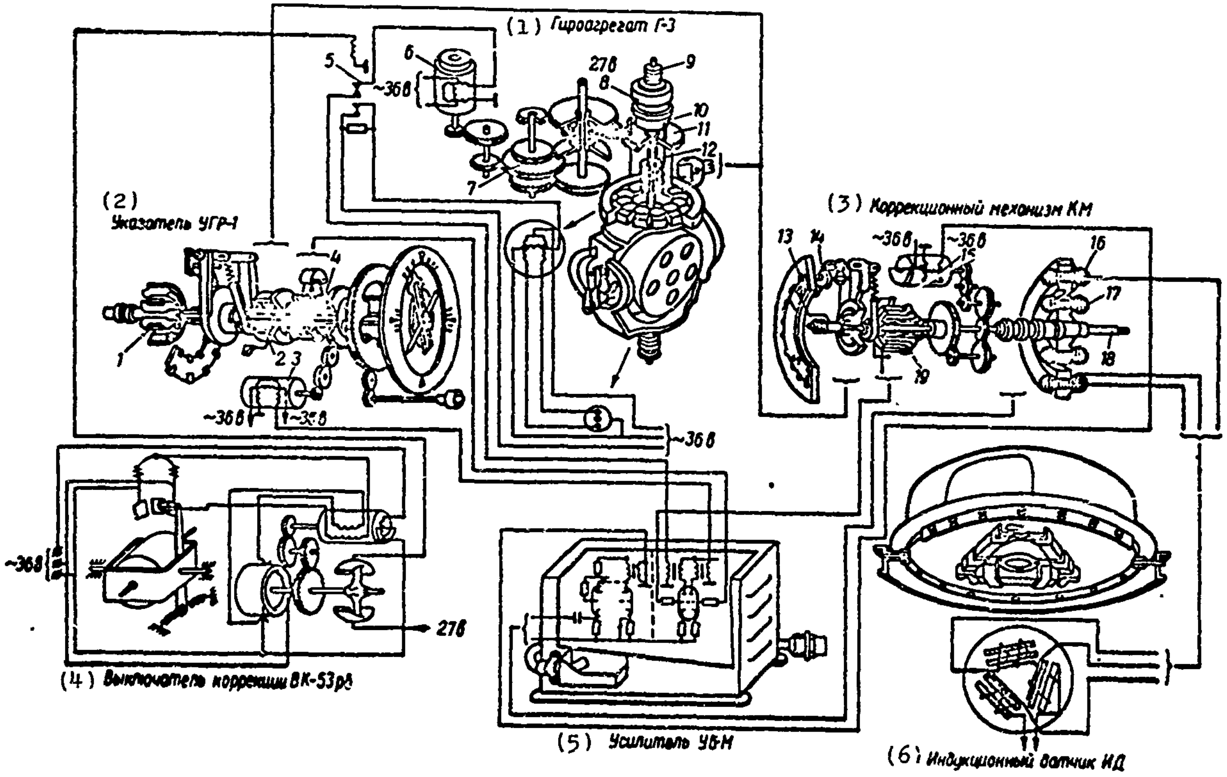
(1) Гироагрегат Г-3
(2) Указатель УГР-1
(3) Коррекционный механизм КМ
(4) Выключатель коррекции ВК-53рб
(5) Усилитель У6-М
(6) Индукционный датчик ИД
~36в
27в
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Fig. 159. The fundamental electrokinematic circuit of the GIK-1 compass: 1 — receiving synchro; 2 — indicator potentiometer; 3 — electric motor of the indicator; 4 — shaft of indicator; 5 — relay; 6 — electric motor of the gyro unit; 7 — reduction gear; 8 — brushes; 9 — slip rings; 10 — potentiometer of the gyro unit; 11 — gear; 12 — vertical shaft of gyroscope; 13 — adjusting screw of the curve device; 14 — curve device; 15 — electric motor of the correction mechanism; 16 — autosyn stator; 17 — autosyn rotor; 18 — shaft of correction mechanism; 19 — potentiometer of correction mechanism.

KEY: (1) G-3 gyro unit; (2) UGR-1 indicator; (3) KM correction mechanism; (4) VK-53RB correction switch; (5) U6-M amplifier; (6) ID induction pickup.

Note: в = V.

The correction mechanism consists of the following main units: the autosyn of electric motor 15 with a reduction gear, potentiometer 19, and curve device 14. The stator of autosyn 16 and the potentiometer are secured in the housing of the correction mechanism. The rotor of autosyn 17 is fastened on shaft 18 which is connected through the reduction gear to electric motor 15. When the electric motor is put into operation shaft 18 transfers rotation through the curve device to the brush holder with the brushes, which in this case additionally can be turned to a certain angle relative to the shaft. The degree of turning depends on the sag in the tape of the curve device and it is secured by adjusting screws 13. The curve device is intended for the elimination of systematic and instrument errors, and also for the reduction of quadrant deviation. Thus current enters from the signal windings of the induction pickup into the windings of the stator of the autosyn. Current from the winding of the autosyn rotor is fed through the slip rings and brushes to input of channel I of the U-6M amplifier. Voltage from the output of channel I is supplied to the electric motor of the KM correcting mechanism.

The contact electrodes of the potentiometer of the correction mechanism are connected with the input of amplifier channel II. Voltage from the output of channel II enters into the electric motor of the gyro unit.

The UGR-1 indicator consists of the annular potentiometer, an electric motor with a reduction gear, a curve device, and a selsyn. During the operation of electric motor 3 shaft 4 together with the scale of the magnetic course rotate through the reduction gear. Potentiometer 2 rotates together with the shaft and as a result of the presence of the curve device there can be additional angular motion relative to the shaft. The curve device is intended for the elimination of instrument errors of indicator and systematic errors of transmission from the potentiometer of the gyro unit up to the indicator potentiometer. The curve device is adjusted at the producing plant.

Three brushes of the indicator potentiometer which are attached in the housing are connected by three wires with the brushes of the potentiometer of the gyro unit. The current outlets of the indicator potentiometer run to the input of channel III of the voltage amplifier and from the outlet of channel III the current enters electric motor 3 of the indicator. The receiving synchro 1 is connected electrically with the selsyn transmitter of the ARK-5 radio compass system.

The principle of operation of the entire system of the compass consists of the following. Direct current of 27 V, applied to the potentiometer of the gyro unit, is taken by three brushes and on a three-wire electrical circuit enters the potentiometers of the indicator and correction mechanism.

The potentiometric systems of the compass will coincide when voltage on the current outlets of the potentiometers of the indicator and correction mechanism is equal to 0 (Fig. 160).

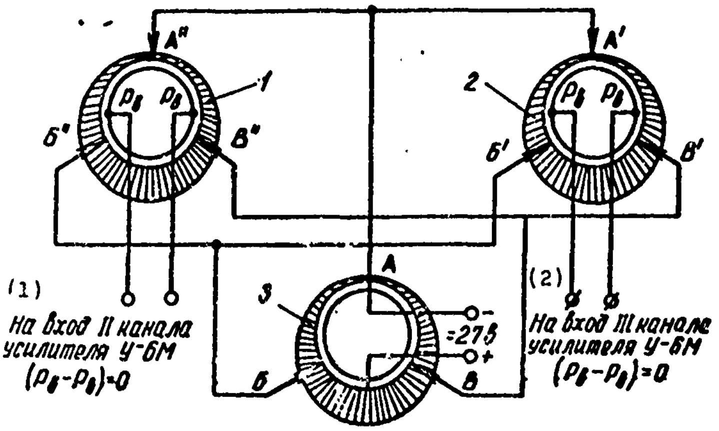
A"
A'
1
2
Рв
Рб
Б"
В"
Б'
В'
A
3
Б
В
-
=27в
+
(1)
На вход II канала усилителя У-6М (Рв-Рб)=0
(2)
На вход III канала усилителя У-6М (Рв-Рб)=0

Fig. 160. The coincidence of the potentiometric systems of the compass: 1 – potentiometer of the KM correction mechanism, 2 – potentiometer of the UGR-1 indicator; 3 – potentiometer of the G-3 gyro unit.
KEY: (1) To input of channel II of U-6M amplifier; (2) To input of channel III of U-6M amplifier.

Such a position can exist only in one case, when the current outlets of the potentiometers of the indicator and correction mechanism have been displaced with respect to the current outlets of the potentiometer of the gyro unit by 90°. In all the remaining cases the potentiometric systems will not match (Fig. 161). In this case on the current outlets of the potentiometers a potential difference will appear, current will go to the amplifier, be converted and amplified, and then it will enter the controlling winding of the electric motor. The electric motor will begin to rotate the brushes or potentiometer until agreement begins, whereupon it is turned off.

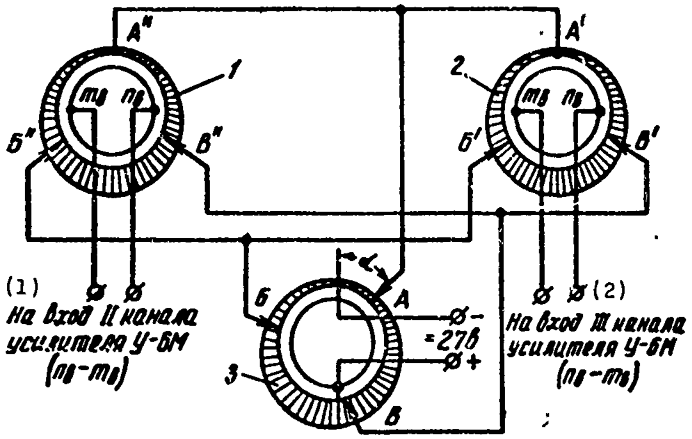
A''
1
Б''
В''
mв
пв
A'
2
Б'
В'
(1)
На вход II канала усилителя У-6М (пв-mв)
Б
A
α
3
В
–
=27в
+
(2)
На вход III канала усилителя У-6М (пв-mв)

Fig. 161. Misaligned position of the potentiometric systems of the compass: 1 – potentiometer of the KM correction mechanism; 2 – potentiometer of the UGR-1 indicator; 3 – potentiometer of the G-3 gyro unit.

KEY: (1) To input of channel II of U-6M amplifier; (2) To input of channel III of amplifier.

The correction mechanism together wth the induction pickup fulfill the same function as the magnetic pickup in the DGMK-3 compass. The position of the rotor of the autosyn with the shaft of the correction mechanism and the brushes arranged on the potentiometer will correspond to the position of the induction pickup relative to the magnetic meridian.

In the case of misalignment of the system of potentiometers of the gyro unit and the correction mechanism on the current outlets of the potentiometer of the correction mechanism a potential difference will appear. Voltage from the current outlets will enter the input of channel II of the amplifier. The amplified and converted current leaving channel II is directed to the controlling winding of the electric motor of the gyro unit, which through the reduction gear will rotate the brushes of the potentiometer of the gyro unit until the system of potentiometers of the gyro unit and correction mechanism agree.

With the turning of the aircraft by angle α the housing of the gyro unit, which is attached on the aircraft, will also turn on this angle relative to the gyroscope. Together with the housing of the gyro unit the brushes connected with it are turned relative to the potentiometer by angle α. The system of potentiometers is misaligned and on the current outlets of the potentiometer of the indicator a potential difference will appear, as a result of which voltage will enter channel III of the amplifier. The amplified and converted current will be directed to the controlling winding of the electric motor. The electric motor through the reduction gear will rotate the potentiometer of the indicator until it agrees with the potentiometer of the gyro unit. Together with the indicator potentiometer the scale will be turned to the same angle α, thus showing the changes in magnetic course.

The gear ratio of the reduction gear of the master motor of the indicator (1:1800) ensures the rotation of the scale to the side of agreement at a rate of 15-20°/s, which during turning ensures the coincidence of the system of potentiometers of the gyro unit and the indicator. Therefore the indicator shows with sufficient accuracy the change in the magnetic course of the aircraft.

The turning of the gyro unit will also cause the misalignment of the system of potentiometers of the gyro unit and the correction mechanism.

The induction pickup will also be turned by angle α relative to the magnetic meridian. In this case there is a redistribution of currents in the signal windings of the sensing head of the pickup. Correspondingly the coil currents of the autosyn stator will be redistributed. The resultant of the electromagnetic field of the stator, having turned by angle α, creates in the winding of the autosyn rotor a current which is fed to the input of channel I of the amplifier. The amplified and converted current from the output of channel I enters the controlling winding of the master motor of the correction mechanism. Through the reduction gear the electric motor will turn the shaft of the correction mechanism together with the autosyn rotor up to agreement, i.e., it will turn by the same angle α, by which the induction pickup will turn. Simultaneously the brushes which are connected to the shaft of the correction mechanism are turned relative to the potentiometer by angle α, and the system of potentiometers of the correction mechanism and the gyro unit after turning remain in coincidence.

In a straight flight the misalignment of the systems of compass potentiometers can occur due to precession and the inclination of the sensing head of the induction pickup due to the influence of accelerations or other causes.

In the event of deviation in the gyroscope of the gyro unit around the vertical shaft because of friction in the shafts or the twenty-four hour rotation of the earth the systems of potentiometers are misaligned and on the current outlets of the potentiometer of the correction mechanism a potential difference will appear. As a result of this through channel II of the amplifier the current will enter the controlling winding of the master motor of the gyro unit. Through the reduction gear the electric motor will turn the brushes of the potentiometer up to the moment of agreement. Since the rate of rotation of the brushes of the potentiometer of gyro unit by the reduction gear of the master motor (gear ratio of reduction gear 1:828,000, which corresponds to the rotation of brushes with a speed of 1-5°/min) is considerably greater than the rate of rotation of the potentiometer of gyro unit because of friction in the shafts or the twenty-four hour rotation of the earth (not more than 0.5°/min), the error will have a small magnitude (not more than 0.25-0.5°/min).

With a deviation of the sensing head of the pickup from the horizontal position because of the accelerations which appear enroute the location of the rods relative to the direction of the magnetic field of the earth is changed. This leads to the redistribution of currents in the signal windings of the sensing head, which in turn will cause a change in the direction of the resultant of the electromagnetic field of the autosyn stator. In the winding of the rotor a current will appear which, in passing by channel I of the amplifier, will enter the controlling winding of the master motor of the correction mechanism.

The electric motor of the correction mechanism, rotating through the reduction gear of the brush of the potentiometer, will begin to misalign the system of the potentiometer of the gyro unit and correction mechanism. The potential difference on the current outlets of the potentiometer of correction mechanism appearing as a result of this will cause the switching on of the master motor of the gyro unit, which will begin to turn the brushes of the potentiometer of the gyro unit to the side of agreement with the potentiometer of the correction mechanism.

In this case the system of potentiometers of the gyro unit and indicator will begin to misalign. The master motor of the indicator will be put into operation and through the reduction gear it will begin to turn the potentiometer of the indicator, and together with it the scale, thus creating an error which is connected with the deviation of the sensing head of the pickup from the action of inertial forces. The short term deviation of the sensing head of the pickup from the horizontal position will practically have no influence on the compass readings in view of the low velocity of rotation of the brush of the potentiometer of the gyro unit (1-5°/min). During the prolonged action of inertial forces on the sensing head of the pickup an error appears on the indicator which will increase at the rate of 1-5°/s.

After the transfer of the aircraft into the established rectilinear movement this error will automatically be eliminated at the same rate at which it grew (1-5°/s) during the turning of the aircraft. The VK-53RB correction switch through the relay 5 (see Fig. 159) mounted in the gyro unit cuts off the power supply of the controlling winding of the master motor of the gyro unit. This excludes the influence of the misalignment of the system of potentiometers of the gyro unit and correction mechanism on the indicator due to the non-horizontal position of the induction pickup during turns, i.e., the potentiometer of correction mechanism will not influence the potentiometer of the gyro unit. The potentiometer of the gyro unit will be connected only with the potentiometer of the indicator. Therefore the indicator will accurately show the turning of the aircraft depending on the gyroscope, but not depending on the induction pickup (as turning on a directional gyroscope). Also through the relay the correction switch reduces current in the excitation winding of the rotor of the motor-corrector and therefore the magnitude of moment being developed by the motor-corrector.

The correction switch operates during the turning of the aircraft at an angular velocity greater than 0.1-0.3°/s and as a result of the presence of the mechanism for delay for 5-15 s after the beginning of the action of angular velocity. Thus the correction mechanism of the compass is cut off only during the execution of turns of a prolonged duration (more than 5-15 s). During the short term deviation of the aircraft from course the correction switch does not operate. Before the switching on of the GIK-1 compass there can be a misalignment between the induction pickup and the position of the brush of the potentiometer of the correction mechanism, the system of potentiometers of the correction mechanism and the gyro unit, and the system of potentiometers of the gyro unit and the indicator.

In 15-20 s after the switching on of power supply and warming up of the amplifier tubes there is an agreement between the systems which connect the induction pickup, the correction mechanism, the gyro unit, and the indicator.

Since the rate of agreement of the potentiometers of the correction mechanism and gyro unit is very low (1-5°/min), then in the event of a maximum misalignment of potentiometers (by 180°) the systems will agree after a prolonged time (up to 3 h), during which the indicator will show an incorrect course. In order to accelerate the agreement of the systems of compass potentiometers after the switching on of the instrument or enroute, there is a button for rapid agreement. When pressed it triggers an electromagnet and switches the friction drive of the reduction gear of the master motor of the gyro unit, and changes the gear ratio from 1:828,000 to 1:3,150, which increases the rate of agreement to 10-15°/s. Such a rate ensures the agreement of the systems of compass potentiometers in no more than 12-18 s.

The UGR-1 indicator of the compass has a selsyn gear drive for the synchronous transfer of the degree of turn of the frame of the ARK-5 radio compass through the pointer of the indicator.

The selsyn system of the radio compass consists of the selsyn transmitter, the rotor of which is connected with the axis of the frame of the radio compass, and a selsyn indicator, the rotor of which is connected with the pointer of the UGR-1 indicator. Constructively the selsyns of the radio compass and indicator are the same. The selsyns have a three-phase stator winding and a single-phase rotor winding. The windings of the stator are connected by a spider, i.e., by some ends in the case of the stator winding are connected in one point, and the other ends have been led out to connecting terminals. The selsyn rotor has a single-phase winding on an iron core, the ends of which are led out to two slip rings attached on the axis of the rotor and electrically insulated from it.

Alternating current is fed to the windings of the rotors of the selsyn transmitter and the selsyn indicator. The windings of the stators of the selsyn transmitter and the selsyn indicator are connected by three wire leads (Fig. 162).

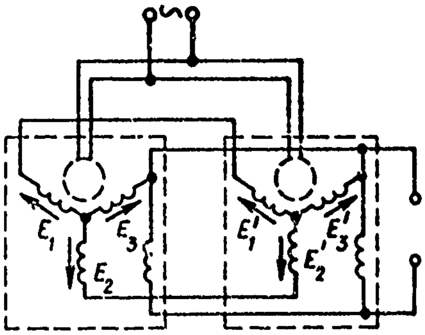

Fig. 162. The layout of the selsyn gear drive.

During passage of alternating current through the windings of the rotors current will be induced in the windings of the stators. The value of the current in each winding will depend on the position of the rotor relative to the windings of the stator. In the event of the same position of the rotors of the transmitting and indicator selsyns relative to the windings of the stator the currents in the corresponding windings of the stators will be equal and directed towards one another:

$$\dot{E}_1 = E_1'; \quad E_2 = E_2'; \quad E_3 = E_3'.$$

Therefore currents in the connecting wires are cancelled out and there will be no circuit currents.

During the turning of the frame of the radio compass the rotor of the selsyn transmitter which is attached on the shaft of the frame will also turn. There will be a redistribution of currents in the windings of the stator of the selsyn transmitter. Current flows into the windings of the selsyn indicator stator on three wire leads. The resultant of the electromagnetic field of the stator will deviate and will force the rotor of the selsyn indicator to turn together with the pointer until the resultants of the electromagnetic field of the stator and rotor of the selsyn indicator coincide. The rotor of the selsyn indicator with respect to the windings of the stator will occupy the same position as the rotor of the selsyn transmitter. The indicator pointer will show the degree of a turn of the frame of the radio compass.

Besides the UGR-1 the UGK-2 logometric type indicator (PDK-45) is connected to the potentiometer of the gyro unit.

For maintaining the principal shaft of the gyroscope of the gyro unit in a horizontal position fluid electromagnetic correction is used (Fig. 163) which consists of sensitive and power parts. The sensitive part is attached to the inner gimbal of the gyroscope and is a liquid switch which consists of a sealed housing filled with a current-conducting liquid in such a quantity, that an air bubble remains inside the housing. In the liquid there are four contacts at an angle of 90° (only two are used). From the contacts the terminals lead outward and to them the controlling windings of the motor corrector are joined. Alternating current is fed to the base of the switch.

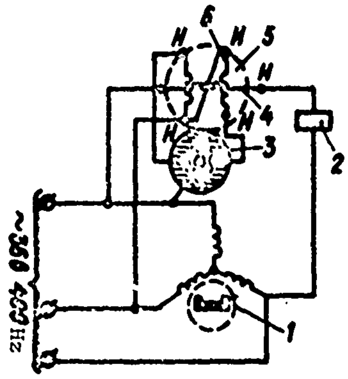

Fig. 163. Layout for the correction of the horizontal position of the shaft of a gyrorotor: 1 – gyro motor; 2 – Relay contact RSM-1; 3 – liquid switch; 4 – excitation windings; 5 – corrector motor; 6 – controlling windings.

The powering unit of correction is the motor corrector, which consists of a rotor and a stator. The rotor consists of a packet of plates made of electrotechnical steel, in the grooves of which three windings have been placed: one excitation winding and two controlling windings. The stator is a packet of plates made from electrotechnical steel flooded with an aluminum alloy which forms the short-circuited loops of the winding.

The rotor is fastened to the outer frame of the gyroscope, and the stator – on the cover of the gyro unit.

The motor corrector is a two-phase multipolar reversible asynchronous motor which operates in a restrained mode. If the axis of the rotor of the gyro motor is in a horizontal position the liquid switch will also be arranged horizontally, the air bubble will occupy a mid-position and both contacts will be overlapped by current distributing liquid. In both controlling windings an equal current, but opposite in direction, will enter. These currents together with the current of the excitation winding will create two oppositely rotating electromagnetic fields of equal intensity, as a result of which the total moment of the motor corrector will be equal to zero.

With a deviation of the principal axes of the gyroscope from the horizontal position because of friction in the shafts or the twenty-four hour rotation of the earth the liquid switch, which is connected with the inner frame of the Cardan joint, will also incline itself and the bubble of air in it will be displaced. One of the contacts will be out of the liquid, as a result of which current in the controlling winding connected with this contact is decreased. The current passing in the second controlling winding together with the current passing in the excitation winding, which is shifted in space and in phase (in time), forms the rotating electromagnetic field which, by intersecting the stator during its rotation, leads currents into it. As a result of the interaction of the electromagnetic fields of the rotor and stator a twisting moment appears which will strive to turn the rotor relative to the stator. Since the rotor is fastened on the outer frame of the gyroscope, then this moment will cause precession, the principal axes of gyroscope will return to a horizontal position, and the action of the correction moment will cease.

Determination and elimination of deviation in the GIK-1 compass

Deviation is the deflection of the compass needle from the magnetic meridian. Deviation appears as a result of the action on the magnetic structure of the compass of the magnetic field of the aircraft, which is created by ferromagnetic masses and various sources of electromagnetic fields. For reducing the influence of the magnetic field an induction pickup is mounted in the wing.

Deviation is defined as the difference between the magnetic and compass course of the aircraft

$$\Delta_k = MK - KK.$$

In the GIK-1 compass semicircular deviation is eliminated by a deviation instrument, and quadrant – by a curve device mounted in the correction mechanism.

During the installation of the compass on the aircraft initially the mounting error is removed. For this they determine the error on four basic points (0, 90, 180, and 270°) and they calculate the magnitude of the mounting error using the formula

$$K = \frac{K_{0^\circ} + K_{90^\circ} + K_{180^\circ} + K_{270^\circ}}{4}.$$

A mounting error of more than 1° is removed by rotation of the induction pickup relative to the longitudinal axis of the aircraft. For this it is necessary to loosen three screws which secure the pickup and turn it by the magnitude of the mounting error.

After this the semicircular deviation is removed, for which the deviation on magnetic headings of 0 and 180° is measured the values obtained are added and divided by two, and then, turning the N-S roller of the deviation instrument, it is brought to the mean value obtained. Thus deviation on courses of 0 and 180° will be the same. The same is done on courses of

90 and 270° and by the rotation of the E-W roller of the deviation instrument the mean value of deviation on these sources is established. After the elimination of semicircular deviation the clamp screw on the rollers of the deviation instrument is tightened and it is anchored by a brass wire.

Then the quadrant deviation has to be eliminated. Quadrant deviation, the systematic and instrumental compass errors, are eliminated by the curve device of the correction mechanism on 24 magnetic headings. For the elimination of the quadrant deviation the aircraft is established on a magnetic heading of 0°. In the correction mechanism three screws are unscrewed and, taking hold of the head, the cover is removed. Under the cover in the correction mechanism arranged along the circumference are 24 adjusting screws of the curve device, a scale, and a pointer.

With a special screw driver the adjusting screw located opposite the pointer tip is rotated while observing the readings on the indicator dial of the UGR-1 (the button for rapid alignment in this case should be pressed). If the deviation is positive, then the adjusting screw must be rotated counter clockwise and vice versa. The rotation of the adjusting screw must be carried out up to the complete elimination of deviation. In the same way deviation is eliminated on all 24 courses (0, 15, 30, 45°, etc.).

During the elimination of deviation by the curve device the adjusting screws are displaced from the mid-position, therefore prior to approaching the repeated elimination of deviation by the correction mechanism, which earlier underwent adjustment, it is necessary to install the adjusting screws in the mid-position. For this it is necessary to complete the following. Turn on the GIK-1 compass. Rotating the magnet around the induction pickup, establish the pointer of the correction mechanism on the zero mark of the scale. Rotating the adjusting screw, located opposite the pointer tip (the button for rapid alignment should be pressed), establish zero according to the scale of the UGR-1 indicator.

Thus, having established the pointer of the correction mechanism on the mark of the scale every 15°, the same readings are attained on the scale of the correction mechanism and on the scale of the UGR-1.

In the case of replacement of the induction pickup and the correction mechanism on the aircraft it is necessary to perform a repeated elimination of deviation by the above-described method.

Deviation of the radio compass

The deviation of the radio compass Δ_p is an error induced by the distortion of the electromagnetic field of the aircraft. Positive deviation increases the reading of the radio compass, negative - reduces it.

The correctness of the elimination of radio deviation in flight is checked by means of the direction finding of a known radio station on three-four courses on the scale of course angles of radio station plotted on the UGR-1 indicator (outer scale).

In the case when the bearings are incorrect, then it is necessary to eliminate radio deviation and to adjust the compensator of radio deviation inside the fuselage ARK-5 loop antenna.

Prior to elimination of radio deviation it is necessary to adjust the compensator on zero correction, i.e., to establish that profile of the curve at which the rotor of the selsyn will rotate synchronously with the frame. The round section of the bed of the curve with the center which coincides with the center of the axis corresponds to this position. For the elimination of deviation in the readings of the UGR-1 dual indicator it is necessary:

1. To establish the aircraft on the assigned course angle of radio station (KUR) [КУР] after every 30°.

2. On the indicator dial opposite the fixed zero index determine the compass heading (KK), and opposite the end of the radio pointer – the magnetic radio bearing (ORP) [ОРП].

3. Compile a table (Table 18), determining radio deviation according to the formula

$$\Delta_p = \text{ОРП} - \text{КУР} - \text{КК}$$

(if Δ_p is less than 180° in absolute value), and using the formula

$$\Delta_p = \text{ОРП} - \text{КУР} - \text{КК} + 360^\circ$$

(if Δ_p is more than 180° in absolute value).

4. From the findings construct a chart of the dependence of radio deviation on the course angle of the radio station.

5. Based on the chart obtained adjust the compensator of radio deviation.

Table 18.

КУР	КК	ОРП	ОРП—КК—КУР	Δ_p
0	12	16	+4	+4
30	352	23	—359	+1
60	330	27	—363	—3
...	...	...	...	...
240	135	20	—355	+5
270	121	29	—362	—2

The construction of the chart and the adjustment of compensator is done by the method expounded in the description of the ARK-5 radio compass.

Checking the GIK-1 compass prior to flight

Prior to flight it is necessary to check:

1. The appearance of units, are there any visible defects.

2. The firmness of attachment of units.

3. The reliability of connection of plug-type connectors.

4. The position of the sensitivity control of the amplifier.

The sensitivity control of the U-6M amplifier for middle latitudes is established in the position noted by figures 3 and 4, for high latitudes – by the figure 4 or 5, and for latitudes close to the equator – by figure 2 or 1.

5. The serviceability of the entire set of the compass. For this it is necessary to switch on the power of the compass and in 1-3 min, having pressed the button for rapid alignment, complete the alignment of the compass systems.

Then with the button for alignment pressed bring a permanent magnet (or any steel object) to the induction pickup so that the indicator dial would turn by a certain angle, whereupon release the button and remove the magnet (or steel object).

In 15-20 s press the button and see that the scale, which is turning smoothly, should return to the initial aligned position. If after the alignment of the scale there are undamped oscillations with an amplitude greater than 1°, then it is necessary to decrease the sensitivity of the amplifier, turning the sensitivity control counter clockwise with a screwdriver until the oscillations disappear.

Switching on the compass. Use of the GIK-1 compass in flight

Before takeoff, but no earlier than 3 min after the turning on of power, press the button for rapid alignment and retain it until the movement of the indicator dial ceases. At the maximum misalignment of readings of the induction pickup and indicator alignment will begin in not more than 20 s.

In flight the button for rapid alignment can be used only during horizontal straight flight at a constant speed. For the convenience of use of the compass in flight it is recommended to establish the course control point adjuster of the indicator on the assigned compass course.

In flight the scale of the course with the course control point adjuster and the pointer of the radio compass will be oriented in space because they are connected correspondingly with the magnetic field of the earth and with the radio station and the index in the upper part of indicator and the scale of course angles of the radio station will turn together with the aircraft. Therefore during turning of the aircraft the course scale with the course control point adjuster and the pointer of the radio compass turn to the side opposite the turn (view of indicator corresponds to the view from the aircraft to the earth in contrast to the PDK-45 indicator).

On the UGR-1 indicator it is possible to determine the course of an aircraft and the bearing of the radio station, which facilitates the execution of active flight to the radio station and from the radio station under the condition of equality of the actual radio station bearing and assigned.

The compass heading is determined on the basic (inner) scale opposite the upper fixed index.

Magnetic radio station bearing is determined on the same scale opposite the pointer tip of the radio compass.

The reciprocal bearing is found opposite the reverse (shortened) end of the pointer.

The course angle of the radio station is read on the supplementary outer scale opposite the end of the needle of the radio compass.

The needle of the course control point adjuster can be established on the assigned heading (the radio station bearing).

Active flight to a radio station and from a radio station

Let us assume that the aircraft, flying to a radio station, was deflected from the planned course line (LZP) [ЛЗП] (Fig. 164). Here the angle between the pointers of the radio compass and the course control point adjuster characterizes the error of the position, and the angle between the pointer of the course control point adjuster and the upper fixed index – the error of heading. For bringing the aircraft to the planned course line it is necessary to shift the aircraft from position a to position b, i.e., to unroll it to the left to the approach course, comprising an angle γ with the planned course line (the angle between the pointer of the course control point adjuster and the upper fixed index).

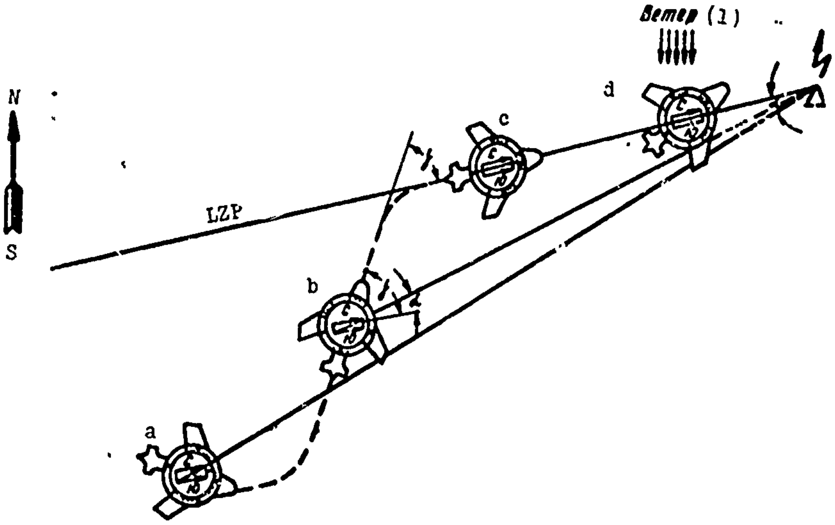

Fig. 164. Active flight to a radio station: a) initial position; b) movement to planned course line; c) flight on planned course line without cross wind; d) flight on planned course line with a cross wind.

KEY: (1) wind.

In proportion to the approximation of the aircraft to the planned course (line of the assigned radio station bearing) the angle between the pointers of radio compass and the course control point adjuster will be reduced, and when the aircraft intersects the planned course line the pointers will coincide. And if we continue the flight on the approach course then there will be an error in the heading which is characterized by the angle between the pointer of the course control point adjuster and the upper fixed index. Therefore, before reaching the LZP it is necessary to begin to turn (to the right). The beginning of the turn is determined from the angle between the pointers of the radio compass and the course control point adjuster (i.e., from angle α which is the difference between the real and assigned radio station bearing), considering the distance to the radio station and the speed of the aircraft. When the aircraft comes out on the LZP the pointers of the radio compass and the course control point adjuster will coincide and if there is no cross wind they will coincide with the fixed index (position c). For combining the pointers in the event of a cross wind it is necessary to turn the aircraft to an angle of drift which is shown by the combined pointer of the radio compass with the course control point adjuster on special scale which is located near the fixed index (position d).

Flight from a radio station is distinguished from flight to a radio station by the fact that the rear end of the pointer of the radio compass will coincide with the pointer tip of the course control point adjuster (Fig. 165). With the approach of the aircraft to the planned course line the error connected with the direction of flight will be characterized by the position of the upper fixed index relative to the course control point adjuster on that half of the scale onto which the pointer of the radio compass is directed.

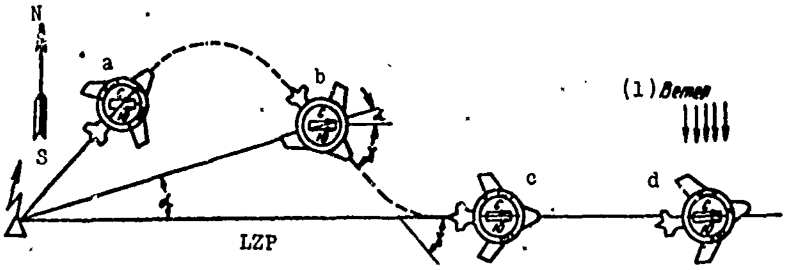

Fig. 165. Active flight from a radio station: a) initial position; b) approach to the planned course line; c) flight on the planned course line without a cross wind; d) flight on the planned course line with a cross wind.

KEY: (1) wind.

For the execution of active flight it is necessary to maintain a course on which the pointers of the radio compass and the course control point adjuster will coincide. If the pointers diverge then it is necessary to combine them by turning the aircraft so that the upper fixed index would be on that half of the scale relative to the course control point adjuster onto which the pointer of the radio compass is directed.

Using the UGR-1 indicator it is possible to execute a landing in the OSP system. For this on the scale of the course angles of the radio station there are triangular indices arranged every 90°, and divisions which correspond to the values of the KUR [radio station angle of approach] at which it is necessary to begin the execution of the second, third, and fourth turns in the construction of a "large box." After the traverse of the radio station with a landing pattern in the time indicated in the instructions it is necessary to begin the first turn. It is necessary to bring the aircraft out of the turn at that moment when the pointer of the course control point adjuster coincides with the triangular index on the external scale, which corresponds to the course angle of the radio station equal to 90°. Then, retaining the pointer tip of the course control point adjuster on the triangular index, straight flight is continued until the pointer of radio compass falls on the course angle of the radio station indicated for the beginning of the second turn. The second turn must be executed prior to the moment of the combination of the pointer of the course control point adjuster with the following triangular index, which corresponds to KUR = 180°. Straight flight is executed until the pointer of radio compass indicates the necessary KUR for the beginning of the third turn. In the same way the third and fourth turns are executed. After the fourth turn the emergence of the aircraft on the landing course is ensured with an accuracy of ±3°.

The determination of the magnetic bearing of the radio station on the UGR-1 facilitates the determination of aircraft position from a neighboring radio station.

The location of the units of the GIK-1 compass on the aircraft

The ID induction pickup is located in the left cantilever of the lower wing. The G-3M gyro unit, the KM correction mechanism, U-6M amplifier, and VK-53RB switch are mounted under the floor of the cockpit (right), between frames Nos. 4 and 5 of the fuselage. The SK-11 terminal box is fastened to frame No. 4 under the floor on the right. The UGR-1 indicator is located on the left half of the instrument panel together with the 5-K button for rapid alignment. The UGK-2 indicator is located on the right half of the instrument panel together with the 5-K button for rapid alignment.

UPZ-48 Position Indicator for Oil Cooler Flaps and the UZP-47 for Flaps

The position indicator for the flaps (UPZ-48) is used for the indication of the position of the oil cooler flaps.

The indicator of assigned position (UZP-47) is intended for the indication of the lowering of flaps in degrees.

The fundamental principles of operation and the construction of these two instruments are completely the same with the exception of the graduations on the scale. The instrument consists of a pickup and an indicator. The pickup is an annular potentiometer which through gears, a guide, and levers is connected with the double arm rocking device of the flap control (with the shaft of the flap of the oil cooler). Current from the aircraft electrical wiring system is fed to the annular potentiometer. Rigidly connected to the housing of instrument are three brushes which are arranged on the annular potentiometer at an angle of 120° to each other. These brushes are connected by wires with the three fixed windings of the logometer of the indicator, also located at an angle of 120° to one another. Inside the windings of the logometer there is a permanent magnet with a pointer. Current is taken from the annular potentiometer by brushes and is directed to the windings of the indicator logometer. The permanent magnet with pointer is established on the resultant of the electromagnetic field of the windings (Fig. 166). With a position change of flaps (flaps of the oil cooler) the annular potentiometer will turn and the brushes will occupy a new position with respect to the current leads, which will cause the redistribution of currents in the logometer windings, as a result of which the resultant of the electromagnetic field of the windings will turn, having forced the permanent magnet with pointer to turn.

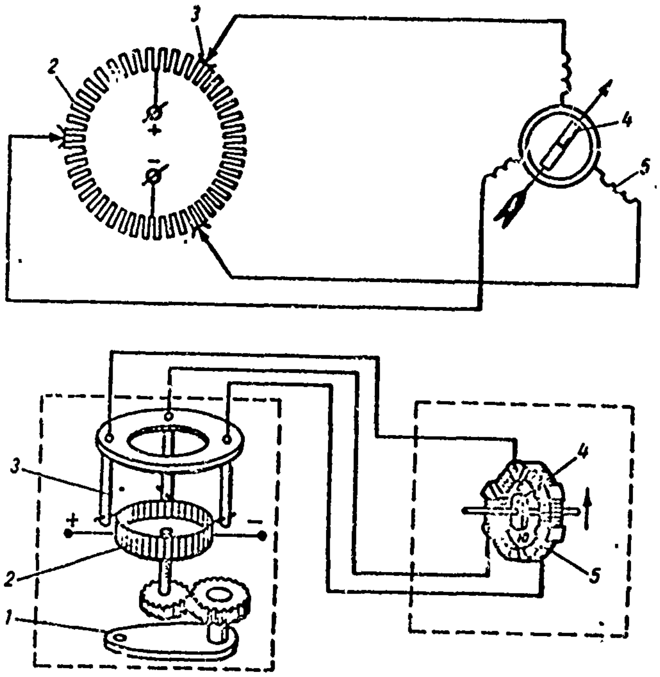

Fig. 166. Fundamental and electrokinematic layout of the UZP-47 indicator of assigned position: 1 – carrier; 2 – potentiometer; 3 – brush; 4 – magnet-rotor; 5 – winding of stator.

VA-3 Voltammeter

The VA-3 voltammeter is intended for controlling the mode of operation of the power source on the aircraft. The instrument is combined because it can show the current or voltage. Normally the instrument is an ammeter which indicates current. When a button which is found on the base of the instrument is pressed it becomes a voltmeter and indicates voltage.

For separate use the instrument has two scales: lower – for the measurement of current with two-way numbering 40-0-120 A, and upper – for the measurement of voltage with a two-way numbering 10-0-30 V.

Figure 167 shows the electrical circuit of the voltammeter. The shunt is included in series in the plus circuit of the generator. During the operation of the instrument as an ammeter current from the generator, passing through the shunt, will create on it a voltage drop which is transferred to mobile frame P. With an increase in current passing through the shunt, voltage on mobile frame P increases and therefore the pointer of the instrument will be deflected to a greater degree.

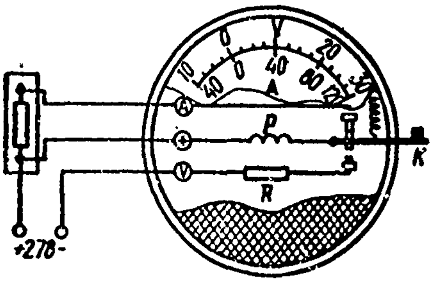

Fig. 167. VA-3 voltammeter.

When button K is pressed the upper contacts are opened and the lower closed and the instrument is connected to the plus and minus electrical circuit, operating as a voltmeter. Here resistance R is connected in series to the mobile frame of instrument, thus damping a considerable part of voltage in it (the frame is designed for voltage on the order of 75 mV). On the face of the instrument a mechanical correction screw is installed for setting the pointer on 0.

CHAPTER VII

SPECIAL EQUIPMENT ON THE An-2M

§ 37. ELECTRICAL EQUIPMENT

The power supply of consumers of electric power on the An-2M is accomplished by direct current of 27 V, alternating current of 115 V 400 Hz, and variable three-phase current of 36 V 400 Hz.

Unlike the An-2, on the An-2M special argicultural equipment is installed which is a powerful consumer of electric power. Therefore on the An-2M more powerful d-c sources of electric power have been installed. The basic d-c source is the VG-7500 helicopter generator with a power of 9000 W. The stand-by source of electric power is the 12-SAM-28 storage battery.

In the case of the installation of three D-2500A electric motors for sprayers on brackets and in the tail a second VG-7500 generator will also be installed on the aircraft. A place has been provided for it on the drive housing (at present it is covered by a cap).

The source of power of single-phase alternating current of 115 V 400 Hz is the PO-250 converter. If an SRO [responder] is installed on the aircraft, then instead of the PO-250 the more powerful PO-500 converter is used.

For the power supply of aircraft gyroscopic instruments with variable three-phase current with a voltage of 36 V and frequency of 400 Hz a PT-125Ts converter is installed.

The networks of direct current and variable alternating current of 115 V are carried out on a single line. The negative wire for them is the metallic airplane fuselage. In the twin-wire arrangement only one consumer is powered - the UT-6D electrical mechanism for the elevator trim tab.

All switches, selectors, and the AZS [automatic circuits protection] are concentrated on the instrument panel, the pilot's left panel, and on a central control panel. The protection of the circuits for the consumers of electric power is carried out by TP inertia fuses, SP liquid fuses, and by the AZS. Some of the automatic units of the AZS are simultaneously the switches of the consumers.

Wiring on the aircraft is carried out in the form of open strands of BPVL [type of wire cable] wires of various section. For the elimination of interference of electrical circuits of radio equipment and instruments there is shielding.

§ 38. D-C SOURCES OF ELECTRICAL ENERGY

VG-7500 Helicopter Generator

The VG-7500 helicopter generator is a six-pole d-c shunt machine with three interpoles. It is installed on the drive housing below behind the motor. The direction of rotation of the generator is left, if we look from the side of the drive.

Forced cooling of the generator is accomplished by means of blowing an opposite air flow (on a helicopter - from the fan) through it with a total pressure head of intake pipe - 200 mm H_2O. The intake pipe can turn within the limits of an angle of 120°

depending on the requirements of mounting. The air coolant passes along the hollow channels inside the armature, and also in the gap between the armature and the magnetic system of the generator. During operation on the ground, when there is no opposite air flow, the cooling of the generator is ensured by the impeller of the fan set on the armature shaft. In this case from the generator it is possible to take a load which comprises 15% from rated.

Basic technical data for the VG-7500

Rated voltage, V.............	28.5
Power (at a voltage of 30 V), W..........................	9000
Range of operating revolutions, rpm.............	5000-8000
Rated current, A.............	300
Maximum current (for 1 min), A..........................	450
Maximal current-carrying capacity (for 10 s), A.......	600
Number of brushes...........	6
Brand of brushes.............	MGS (7.2 × 17.5 × 24)
Weight, kg..................	24.5
Period of service, hr........	300

Operation of the generator. During operation it is necessary to watch for the cleanliness of the generator, to clean its housing from oil and dirt in proper time (wash with kerosene). After every 50 h of flight it is necessary to remove the shielding tape and check the condition of the commutator and brushes.

During normal operation on the surface of commutator a brilliant film with light darkening is formed (the so-called "varnish"), but without traces of scorching and soiling. In the case of soiling (greasy dull black film) the commutator has to be rubbed thoroughly with a clean napkin moistened in B-70 gasoline (without admixtures). If the soiling is not removed the commutator has to be cleaned with "00" glass paper. When cleaning the commutator it is necessary to take the brushes out of the sockets, to press a piece of glass paper twisted on a piece of wood to the commutator face, and to turn the armature of the generator.

After 100 h of flight everything has to be done just as after 50 h, and furthermore it is necessary to check:

the tightening of bolts of terminal ends;

the attachment of the hose of the air duct to the branch pipe of the generator;

the attachment of the cap to the panel by a nut (in order that it would not suck in air);

the tightening of all threaded connections;

the absence of rolling of the commutator panel (rolling appears in the case of a weak attachment of the hose of the air duct or a long length of loose terminal ends of wires);

the condition of brushes and their height.

If the brushes are worn out to H = 18 mm they have to be replaced by new (height is determined from the side of the greatest plane of the brush) and rubbed thoroughly with "00" paper. New brushes should enter the sockets without the least jamming and without rolling.

When the brushes are seated to the commutator the generator should be run for 2-3 h with a load of 50-100 A. Seating is considered final when the contact surface of the brush with the commutator is no less than 70-80% of area of section, and on the commutator a satisfactory varnish was formed.

The VG-7500 generator on the An-2M operates in a set with the following equipment:

differential minimum relay DMR-400D;

carbon-pile regulator R-27;

antihunt transformer TS-9-M2;

remote resistance VS-25B;

automat for surge protection AZP-1MB.

Differential Minimum Relay DMR-400D

The DMR-400D relay is installed in the central distribution system [TsRU] (ЦРУ). The TsRU is placed on the cross wall at frame No. 5 on the right. Access to it is through a hinged panel. The complex apparatus of the DMR-400D is intended for the automatic breaking in of the generator into the aircraft electrical system and disconnection from the aircraft electrical system.

Carbon-Pile Regulator R-27

The R-27 regulator is installed under the floor of the cockpit of the left side between frames Nos. 4 and 5. It serves for maintaining a stable voltage in the VG-7500 generator with a change in the magnitude of load in the aircraft electrical system and the rate of rotation of the armature of the generator in assigned limits.

If two generators are installed on the aircraft then, respectively, two pressure regulators are installed. In this case the R-27 regulators will still accomplish the uniform load allocation between generators working in parallel.

The R-27 regulator is protected with the help of the IP-15 fuse.

Basic technical data on the R-27

Rated controlled voltage, V................	28.5
The limits of change in the voltage of the generator with the help of extension resistance VS-25B during shifting from the midposition, V:	
to an increase of voltage.................	1
to a decrease of voltage..................	3.5
The maximum power being dispersed by the carbon column in the form of heat, W....	85
The mode of operation......................	prolonged
The resistance of the carbon column ShR-9, ohm:	

in a heated state at a pressure of 5 gf	41
in cold state at pressure of 5 kgf	0.36
Service life, h	300

The equipment, electrical circuit, and the principle of operation of the R-27 regulator are analogous to the equipment, principle of operation, and the circuit of the R-25AM regulator on the An-2.

Antihunt Transformer TS-9-M2

The TS-9-M2 is installed in the TsRV. It is intended for increasing the stability of operation of the VG-7500 generator. It is interconnected with the R-27 carbon-pile regulator.

The positive wire from the VG-7500 generator to the aircraft electrical system passes through the window in the steel of the TS-9-M2 transformer and creates a magnetic flow in it. With a change in the current of the generator load the magnetic flow in the steel of the transformer is changed, due to which in the windings of the transformer emf of self-induction is created which is directed towards the source which caused it.

With abrupt changes in the generator load (which takes place on the An-2M with the turning on or off of the agricultural equipment) the R-27 voltage regulator is not in a position itself to instantly restore the assigned voltage and vibrations will be observed in it. In this case in the R-27 regulator the emf of the self-induction of the windings of the TS-9-M2 transformer is used for the more rapid regulation of generator voltage.

Basic technical data for the TS-9-M2

Permissible range of operating temperatures of the environment, °C	from -60 to +50

Permissible relative humidity of the environment, %.............	up to 98
Permissible frequency of vibration of places of attachment, Hz.......	from 20 to 200
Permissible shock overloading.....	fourfold
Mode of operation.................	prolonged

Extension Resistance VS-25B

The VS-25B is installed on the right panel of the pilot's instrument panel next to the generator circuit breaker. With the help of the VS-25B it is possible to manually read just the voltage of the VG-7500 generator within the limits +1 – -3.5 V.

Automatic Device for Surge Protection AZP-1MB

The AZP-1MB is intended for the protection of the d-c circuit from the emergency boosting connected with the overexcitation of the VG-7500 generator. The AZP-1MB is installed under the floor of the cockpit on the right between frames Nos. 4 and 5.

The AZP-1MB works in the circuit with the R-27 pressure regulator and the DMR-400D differential minimum relay.

Basic technical data for the AZP-1MB

Rated voltage, V..................	28.5
Circuit current of power contactors, A................................	not more than 25
Pick-up voltage of the automatic unit during malfunctions, V.......	30-33
Mode of operation.................	prolonged
Period of service of responses....	50

Operating principles. During the emergency boosting of the generator voltage within the limits of 30-33 V over an interval of time of 0.06-1.5 s (depending on the magnitude of overvoltage) a delayed-action relay is triggered in the automatic unit. Because of the deceleration the automatic device does not manage to react to random operating overvoltages. The winding of the delayed-action relay included in parallel to the excitation winding of the generator and reacts to a boosting of voltage in it.

In responding the delayed-action relay switches on an auxiliary relay which in turn switches on a pushbutton contactor.

The contactor responds, stops on the mechanical interlock, and with its contacts cuts off the current of the DMR-400D. The latter disconnects the generator from the aircraft electrical system - the red signal lamp of the generator lights up; in the circuit of excitation winding the generator switches on an additional resistance located inside the automatic device and the voltage of the generator is lowered to 5-8 V; it opens the circuit of parallel operation of generators (if two generators are installed on the aircraft).

In order to again connect the generator into the network it is necessary to press the button on the housing of the automatic device and thereby remove the mechanical interlock. The button of the AZP-1MB can be pressed only after the elimination of the failure in the power supply system. Most frequently the voltage regulator is defective - sticking of the washers of the carbon column, break of the conductor, scorching of contacts in the subpanel. In such cases the voltage regulator must be changed.

12SAM-28 Storage Battery

The 12SAM-28 is the reserve source of electrical power. The make of the battery is deciphered in the following manner:

12 - the number of elements (cell buckets) in the battery;
S - starter;
A - aviation;
M - monoblock;
28 - the capacitance of the battery at A·h at t = 20°C.

The battery is installed in the rear hold in a special aluminum container on the left side between frames Nos. 23 and 24.

Unlike the 12A-30 storage battery the 12SAM-28 has less inner resistance and therefore a low potential drop inside the storage battery during discharge by high current. Thereby the starter mode has been improved.

The battery is placed in a special tray. The connection of the battery to aircraft electrical wiring system is accomplished with the help of a "plug-socket" connection.

The inclusion of the battery into aircraft electrical wiring system is done with the switch "aboard-airport" in the position "aboard." The switch is mounted on the central panel of the instrument panel above.

The TKS-101-DT contactor of the storage battery, the IP-150 fuse, and the 3hA-46 amperemeter shunt are installed in the RK of the storage battery in the rear of the fuselage. [RK - probable meaning "distributing box"].

Basic technical data for the 12SAM-28

Rated voltage, V	24.5
Capacitance during 5-hour discharge by a current of 5.6 A, a·h:	
during the period of the first half-year	28
during the period of the second half-year	23
during the period of the second year	21
Weight of battery with electrolyte, kg	28.5
Discharge is produced up to the achievement of voltage, V:	
on one element	1.76
on the battery	20
Battery works at a temperature of environment, °C	from +50 to -50
The check of the storage battery is done under a load, A	12
The voltage of the loaded battery (during check), V	24

Airport D-C Sources of Electric Power

When the plane is on the flight line for a check of special equipment or for starting the engine the battery car or APA [automatic starter] is used as the sources of electric power. The airport source of electric power is connected to the electrical wiring system of aircraft through the plug for airport power supply ShRAP-250K (on 250 A) located on the left side between frames Nos. 17 and 18.

Next to the ShR a tube is installed which signals about the connection of the airport power supply.

After connection of the ShR it is necessary to set the "aboard-airport" switch on the pilot's instrument panel to the position "airport."

In this case the TKS-101-DT contactor in the RK of the storage batteries responds and switches the airport power source into the aircraft electrical wiring system.

If in the airport power supply polarity is entangled, then it will not switch into the aircraft electrical wiring system because of the presence in the system of a connection of special diodes for the control of polarity.

The airport source will also not switch into the aircraft electrical wiring system if the 2PPG-15 generator circuit breaker on the right panel of the instrument panel remains in the on position. In order to switch the airport source into the aircraft electrical wiring system it is necessary to disconnect the switch of the VG-7500 generator so that one of the contacts of the 2-PPG-15 switch in the "off" position closes the circuit of the TKS-201-DT contactor in the RK of storage batteries, which connects the airport source to the aircraft electrical wiring system.

The d-c sources of electric power on the An-2M are checked in the same order as on the An-2. The voltmeter with switch, amperemeter, and extension resistance are located on the right panel of the instrument panel.

§ 39. A-C SOURCES OF ELECTRIC POWER

PO-250 Converter

The PO-250 converter is the basic source of alternating current with a voltage of 115 V and frequency of 400 Hz. It converts a-c with a voltage of the aircraft electrical system of +28.5 V into alternating single-phase current with a voltage of 115 V and frequency of 400 Hz.

The consumers of single-phase alternating current with a voltage of 115 V and frequency of 400 Hz are:

ARK-9 radio compass;
RV-U radio altimeter;
liquid content gauge in the tank of agricultural equipment DIKZh-4.

The PO-250 is installed under the floor of the cockpit between frames Nos. 4 and 5 on the left of the plane of symmetry of the aircraft, it is put into operation by the AZS-2 automatic device on the central control panel with the inscription "PO-250." The converter is cooled by means of self-ventilation.

Alternating voltage from the PO-250 is supplied to the case "RK-115 V" mounted in the cockpit on the right on the bulkhead of frame No. 5. The "RK-115 V" contains five fuses: one - in the general a-c network, the second - in the circuit of the voltmeter, and three - in the circuits of consumers.

Basic technical data for the PO-250

Supply voltage, V....................	27 ± 10%
Consumed current, A..................	not more than 24.5
Output alternating voltage, V........	115
Output alternating current, A........	2.17
Useful power, W......................	250
Frequency, Hz........................	400
Power factor.........................	0.9
Operating turns, rpm.................	12,000
Efficiency factor, %.................	33
Mode of operation....................	prolonged
Weight, kg...........................	8
Period of service (without repair), h	500

The PO-250 consists of the following parts:

1) single-hull dynamoelectric unit, which includes a d-c electric motor and single-phase a-c synchronous generator;

2) control case which includes devices which ensure remote starting and stopping, the stabilization of output voltage, and filtration from radio interferences.

The case is mounted on the housing of the converter. In the case here is also a rheostat, with the help of which it is possible to manually control voltage within the limits of ±4 V (111-115-119 V).

During the operation of the converter no overloading is allowed. The aggregate capacity of consumers of alternating current should not exceed 250 VA.

The wear of brushes after 500 hours of operation should not exceed 7.5 mm, and the wear of the commutator and rings for this time should not exceed 0.5 mm in diameter.

PT-125Ts Converter

The PT-125Ts serves for the conversion of the d-c voltage of the aircraft electrical system of +27 V into variable three-phase voltage of 36V with a frequency of 400 Hz. It is installed under the floor of the cockpit between frames Nos. 1 and 2 to the right from the plane of symmetry of the aircraft.

The PT-125Ts supplies variable three-phase current aircraft gyroscopic instruments GIK-1M and AGK-47B; it is put into operation with the help of the AZS-10 automatic protection device on the pilot's central control panel with the inscription of "AGK," "PT-125Ts."

Basic technical data for the PT125Ts

Voltage supply, V..................	27 ± 10%
Current consumption, A:	
under load........................	no more than 8
at no-load........................	no more than 4.9
Output alternating voltage, V.......	36
Frequency, Hz......................	400
Useful power, VA...................	125
Alternating current of load, A......	2
Operating turns, rpm................	12,000
Power factor.......................	0.6
Connection of phases...............	star
Efficiency factor, %...............	35
Weight with case, kg...............	5.5

D-C Electrical Power Distribution

Electrical power from the VG-7500 generator enters through the IP-200 fuse into the busbar of the central distribution system TsRU. Electric power from the 12SAM-28 storage battery enters through the IP-200 fuse into the busbar of the RK of the storage battery. Both these busbars are connected by a power lead through the IP-200 fuse. Further from the busbar of the TsRU energy from generator and storage battery is supplied through the power lead and the IP-200 fuse to the busbar of the distributive plate.

The busbars of the instrument panel, the central control panel, and the left panel are connected through inertial fuses to the busbar of the distributive flap. The consumers of electric power are connected to the indicated busbars at the place of their installation and connection.

Besides the busbars of the left panel, the instrument panel, and the central control panel, on the An-2M there is also an emergency busbar for the storage batteries of the central control panel. This busbar under normal conditions is powered from the generator (from the busbar of the distributive plate) through the IP-20 fuse and contactor.

In the case of burn-out of the IP-200 fuse between the TsRU and the busbar of the distributive plate the emergency busbar of the indicated panel will obtain power supply directly from the busbar of the RK of the storage battery through the IP-20 fuse.

Connected to the busbar of the storage batteries of the central panel are the consumers, vital for the continuation of flight and accomplishment of landing: AGB-2, fire-fighting equipment, engine control instruments, and others.

Control of the Sources of Electric Power During Flight

During flight it is necessary to periodically control the operation of the sources of electric power based on the readings of the amperemeter and voltmeter. Voltage in the aircraft electrical system should not exceed the limits of 27.5-28.5 V, and the permanent load on the generator should not exceed 300 A. The generator circuit breaker should always be on - on the ground and in the air. The generator has to be disconnected only in emergency cases, when voltage is changed considerably or the current of the load increases sharply, or large inverse current appears.

In the case of failure of an electrical apparatus or instrument first of all it is necessary to check the integrity of the fuse or the position of the AZS handle of its circuit. In this case the given electrical apparatus or instrument must be disconnected.

§ 40. D-C CONSUMERS OF ELECTRIC POWER

The consumers of d-c electric power are given in Table 19.

Table 19.

Designation	Mark	Place of Installation	Point of Switching On
Electric motor of starter	SA-189	Engine	Switch on the left panel of the instrument panel
Booster coil	KP-4716	Engine mount	Same
Electric glass cleaner	AS-2	In the niche of the canopy	Left panel
Electromagnetic switch for locking the rear wheel	Part 1343	Frames Nos. 22 and 23 along the axis	Central panel of instrument panel
Automatic device for heating of glasses	AOS-81M	Frames Nos. 2 and 3, under the floor, right side	Left panel
Electrical mechanism of the elevator trim tab	UT-6D	Left side of stabilizer	Central panel
Electrical mechanism of the rudder trim tab	UT-6D	Rudder	Same
Electrical mechanism of the aileron tab	UT-6D	Left aileron	
Electrical mechanism of upper flaps	UZ-1-AM	Frames Nos. 9 and 10, ceiling	Instrument panel
Electrical mechanism of lower flaps	UZ-1-AM	Frames Nos. 8 and 9, under the floor	Same

Table 19. (Continued)

Electrical mechanism for control of the doors of the oil cooler	UR-10	Frame No. 1, along the axis	Same
Electrical mechanism for control of the left cowl flap	UR-10	Frame No. 1, left side	"
Electrical mechanism for control of the right cowl flap	UR-10	Frame No. 1, right side	"
Electromagnetic dilution valve	EKR-3	Frame No. 1, left side	Left panel
Electric fuel pump	BPK-4	Frame Nos. 3 and 4, left side	Same
Tank with fire extinguisher head PG	Z-150-L	Frame No. 4 left side	Instrument panel
Left headlight	FS-155	Left side of lower wing	Central panel
Right headlight	FS-155	Right side of lower wing	Same
Taxiing lamp	FR-100	Left side of lower wing	"
Fan	DV-302-TV	Canopy, left side	Left panel
Electric motor for the conditioner compressor	D-4500-K	Frames Nos. 15 and 16, right side	Central panel
Electric motor of ripper	D-2500-A-1	Frames Nos. 5 and 6, under the ceiling	Control wheel
Converter	PT-125Ts	Frames Nos. 1 and 2, right side	Central panel
Converter	PO-250	Frames Nos. 4 and 5, left under the floor	Same

Peculiarities of Starting the Engine

The assembly of units for starting the engine on the An-2M is analogous to the assembly on the An-2. The scheme of starting is given in Fig. 168.

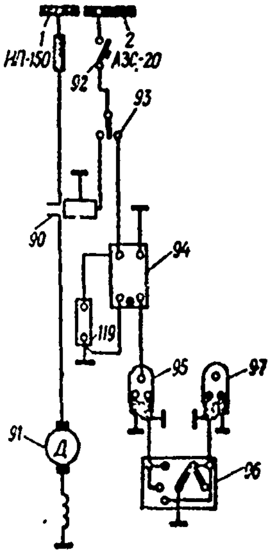

Fig. 168. Basic electrical circuit for starting the engine: 1 - busbar of the distributing board; 2 - busbar of the instrument panel; 90 - K-300D contactor; 91 - SA-189 electric motor; 92 - switch (AZS-20) of the circuit for starting the engine; 93 - PNG-15 switch; 94 - KP-4716 booster coil; 95 - right magneto; 96 - magneto switch PM-1; 97 - left magneto; 119 - RA-176M relay of starter.

On the An-2M instead of the Pn-45M pressure switch on the left panel of the instrument display a hermetic switch of the type PNG-15 with the inscription has been installed and instead of the VM-177 magnetic switch the K-300D contactor has been installed in the arrangement for starting.

The handle of the hand drive of the starter is not mounted in the cargo compartment at frame No. 5, but directly on the engine on the left side.

It is permitted to execute three startings in a row with an interval of 10-15 s, whereupon 30 min is given for cooling.

Electrical Mechanisms of Remote Control

The lowering and retraction of flaps on the An-2M are accomplished by two electrical mechanisms of the type UZ-1AM. The mechanism for the upper flaps is installed between frames Nos. 9 and 10 in the upper fuselage. The mechanism for the lower flaps is located under the floor between frames Nos. 8 and 9.

The RK-UX-1AM housings are located next to the electrical mechanisms. In every housing there are two TKD-201-DT contactors and two TKE-53PD relays, with the help of which remote switching, disconnecting, and reversal of the electric motors of the flap mechanisms are accomplished.

In the power supply circuit of the UZ-1AM electrical mechanisms two AZS-15 automatic protection devices are installed. In the control circuit of the mechanisms there is one general AZS-5. All three AZS's are located on the right panel of the instrument panel. The presence two AZS-15's in the power supply circuit makes it possible to use the upper and lower flaps simultaneously or separately.

The lowering of flaps. If pressure is placed on the button for the lowering of flaps, which is situated on the gas lever, the power supply circuits for the windings of the TKE-58PD relay are closed. The relay triggers and closes three pairs of their own contacts. Therefore the voltage of aircraft electrical system is fed through the AZS-15 and the locked contacts of the TKE-53PD relay to the electromagnetic coupling and the shunt winding of the mechanisms, and also to the series winding for the clockwise rotation of the mechanisms which begin to work and to lower the flaps.

Inside each UZ-1AM mechanism there are two terminal switches of the V-611 type. In any intermediate position of the mechanism these microswitches are found in the locked position and thereby supply "minus" on the TKE-53-PD relay.

In the extreme lowered position of the flaps one of the microswitches opens the circuit of the "minus" relay TKE-53-PD and the

UZ-1AM mechanism is automatically disconnected.

In the extreme retracted position of the flaps another microswitch is triggered and deflects the "minus" from the other TKE-53-PD relay and the latter disconnects the UZ-1AM mechanism.

The position of the upper flaps is controlled by a UZP-47 device arranged on the central panel. In order that this instrument would work it is necessary to turn on the appropriate AZS-5 on the right panel of the instrument panel.

The retraction of flaps. If pressure is placed on the button for the lowering of flaps on the central panel the power supply circuits of the windings of the TKE-53-PD relay are closed. The relay triggers and closes three pairs of its own contacts, due to which the voltage of the aircraft electrical system is fed through AZS-15 and the locked contacts of the TKE-53-PD relay to the electromagnetic coupling, shunt winding (with reverse polarity of voltage) and the series winding for counterclockwise rotation. The UZ-1AM mechanisms rotate in the opposite direction and the flaps are retracted.

In the extreme retracted position of the flaps the microswitches of the retracted position are opened and therefore the circuits of the relay are opened and the UZ-1AM electrical mechanisms are deenergized.

Control of the cowl flaps and the folds for the duct of the oil cooler is accomplished by remote control with the help of three UR-10 electrical mechanisms. Two UR-10's serve for control of the cowl flaps. They are installed on the detachable part of the engine cowling. One UR-10 is intended for remote control of the flaps of the duct of the oil cooler and is placed on its housing.

The electrical mechanisms for the cowl flaps are controlled by one two-pole hermetic 2-PNG-15 switch and the electrical mechanism for the flaps of the oil cooler - by a single-pole hermetic PNG-15 switch. Both switches are mounted on the central panel.

The position of the flap for the duct of the oil cooler is controlled by a UPZ-48 instrument on the central panel.

In the extreme positions of the flaps (opened and closed) the UR-10 is turned off automatically with the help of the microswitches placed in the mechanisms themselves. The protection of the UR-10 mechanisms is carried out in the form of an AZS-5 on the right panel of the instrument panel.

Control of the aileron trim tab, rudder trim tab, and elevator trim tab is remote and is accomplished with the help of three UT-6D electrical mechanisms. The UT-6D aileron and rudder trim tabs are switched on by pressure hermetic single-pole PNG-15 switches located on the central panel. The basic electrical circuit for control of the electrical mechanisms of the trimming tabs is given in Fig. 169.

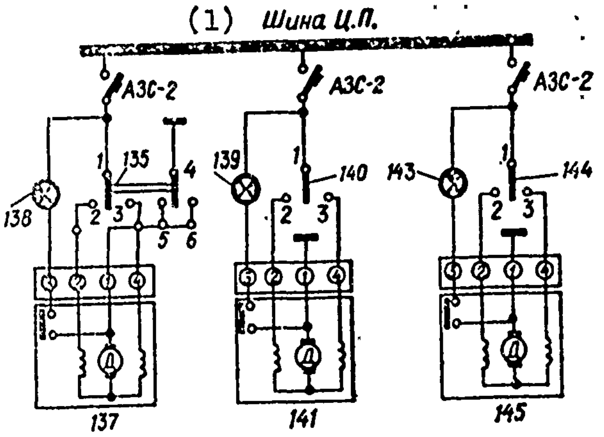

Fig. 169. Basic electrical circuit of control of the electrical mechanisms of the trimming tabs: 135, 140, 144 - pressures switches for control of the trim-tab of the altitude control, the rudder trim tab, and the aileron tab; 136, 139, 143 - lamps signalling the neutral position of the appropriate trimming tabs; 137, 141, 145 - the electrical mechanisms of trimming tabs for altitude, rudder, and aileron control, respectively.

KEY: (1) Busbar Ts. P.

The power supply of the electrical mechanism for the elevator trim tab is carried out in a twin-lead circuit and therefore in its control circuit a two-pole hermetic 2PNG-15 switch has been installed on the central panel. Next to the switches are the lamps signalling the neutral position of the corresponding trimming tab.

The System for Signalling of Fire SSP-6

The electrical circuit of fire prevention system (Fig. 170) ensures:

the signalling of the onset of fire in the engine;

manual control of fire extinguishing;

checking of the condition of fire-fighting equipment.

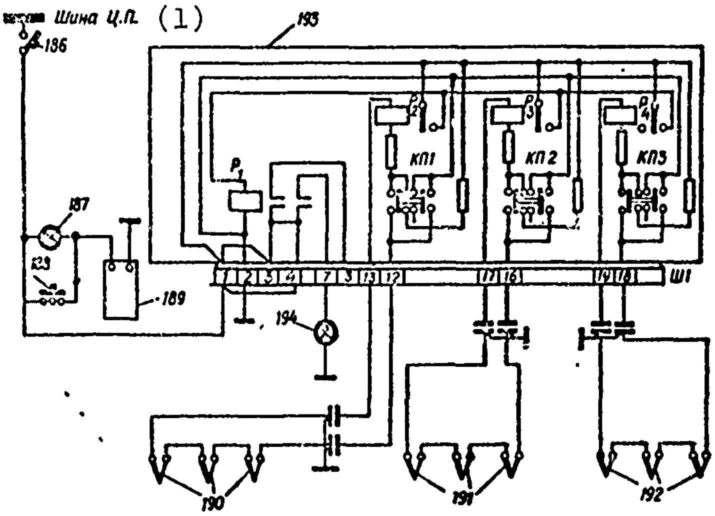

Fig. 170. Basic electrical circuit of the fire prevention system: 186 - automatic device of protection AZS-5; 187 - yellow lamp signalling the good condition of the fire extinguisher head; 188 - 204K button for connection of fire extinguishing; 189 - bottle with fire extinguisher head; 190 - I group of sensors DTBG; 191 - II group of sensors DTBG; 192 - III group of sensors DTBG; 193 - actuating unit SSP-6BI; 194 - red lamp signalling of fire.

KEY: (1) Busbar Ts. P.

It includes the following elements:

nine DTBG sensors (see Fig. 170, pos. 190, 191, 192) connected in series of three sensors in one group and arranged in most fire susceptible places of the engine;

actuating unit SSP-6BI 193 arranged under the floor on the right;

bottle with fire extinguisher head 189, filled with carbon dioxide, installed on the right under the floor between frames Nos. 3 and 4;

red lamp 194 signalling about fire and located on the left panel of the instrument panel;

button 188 for controlling the extinguishing of fire and located next to the lamp on the left panel of the instrument panel;

AZS-5 automatic protection device 186 of the SSP-6 system installed on the central panel.

Operation of the system. The DTBG sensors are batteries made from series connected thermocouples. The principle of operation of the DTBG sensors is based on the phenomenon of the development of emf in the thermopile in the case of a change of temperature of the surroundings.

When the sensors are surrounded by a medium, the temperature of which increases by no less than 2°C per second and reaches 170°C emf is developed in the sensors which is sufficient for triggering the sensitive polarized relay in the BI-6 actuating unit.

On the engine there are three groups of sensors. Each group is connected to its own relay in the BI-6 unit.

With the onset of emf in the sensors, for example in the first group 190, in BI-6 the unit relay P_2 is triggered and it feeds voltage to intermediate relay P_1 which in turn triggers and switches on red lamp 194 for signalling of fire.

The pilot, having noted the signal, is obliged to press fire extinguishing button 183. When the button is pressed voltage from the aircraft electrical system is supplied to the cartridge of bottle 189. The cartridge is detonated and opens the admission of fire extinguishing mixture into the engine. Tube 187 signalling the satisfactory condition of the pyrohead of bottle goes out.

When checking the condition of the SSP-6 system it is necessary:

to switch on the AZS-5, with this yellow lamp 187, signalling about the good condition of the pyrohead of the bottle, should light up. Simultaneously voltage from the aircraft electrical system is supplied to the check buttons KP-1, KP-2, and KP-3, arranged on the BI-6 unit;

with the successive pressing of these buttons the red lamp signalling of fire should light up. By pressure on the button circuit voltage is supplied through the circuits of sensors to the sensitive relays. The relays respond, imitating a fire.

Such a check makes it possible to be convinced of the satisfactory condition of all the elements in the fire extinguishing circuit: relays P_1, P_2, P_3, P_4 of the DTBG sensors of the lamps for signalling of fire.

In the case of an inoperative circuit of sensors or relays or lamp the signalling lamp will not light up when the button is pressed.

Electrically Heated Glasses

The two glasses for the pilot, the left side and the middle (both types TSBP-17), have film electrical heating. The temperature of the electrically heated glasses is regulated by the AOS-81M automatic device installed under the floor between frames Nos. 3 and 4. The AOS-81M is switched on with the help of AZS-2 on the left panel. Two contactors for switching on the heating (TKD-201DT) are located on the control panel. Also located there are two IP-50 fuses in the power circuits for the heating of glasses. The electric circuit for the heating of glasses is shown in Fig. 171.

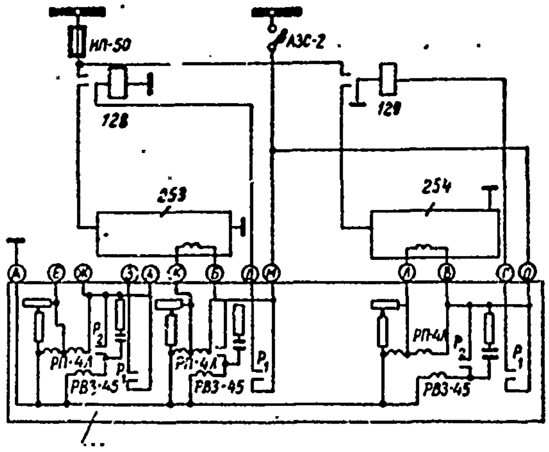

Fig. 171. Basic electrical circuit for the heating of glasses: 128, 129 - contactors for turning on of heating; 130 - automatic device AOS-81M; 253, 254 - middle and side glass.

For the heating of two glasses a current of about 31 A is necessary. At a surrounding air temperature of +30°C and higher the heating of glasses will not be switched on, which one ought to keep in mind during checking on the ground. The electrical heating of glasses begins to operate effectively only in 5-6 min after being turned on.

At the case of cracking of the outer glass in the case of sparking in the heating during flight or on the flight line flight with such a glass is permitted with electrical heating turned off up to the home airfield.

Electrical Windshield Wiper AS-2

The electric motor of the windshield wiper is installed in the niche of the canopy and is fastened by two brace clamps. Reduction gear with brush is installed on the left frontal glass of the canopy.

The switching on of the windshield wiper is accomplished with the help of the AZS-5 on the left panel. For a reduction in radio interference during the operation of the AS-2 the FT-14 filter has been included in the circuit of the electric drive.

The electrical diagram of the AS-2 is shown in Fig. 172.

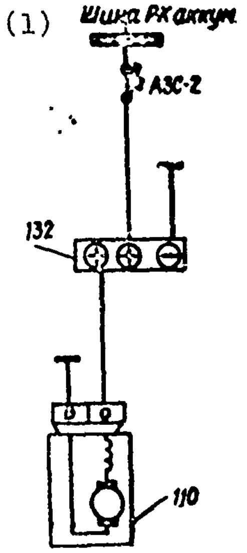

Fig. 172. Basic electrical circuit for control of the electrical mechanism of the windshield wiper: 132 - filter FT-14; 110 - mechanism AS-2.

KEY: (1) Busbar for the RK of the storage battery.

Airborne Conditioner

The airborne conditioner is intended for cooling of the air in the cockpit during the hot season.

The conditioner is a single-stage compression cooler with a self-contained cycle. The cooling of air is forced and is accomplished with the help of a fan. The heat being led away during cooling is absorbed by the refrigerant (Freon-12), the temperature of which is lower than the temperature of the cooled air.

The assembly of the conditioner includes:

the evaporator unit (part 2440), installed in cockpit on the wall of frame No. 5 on top behind the pilot's seat;

the capacitor unit with fan, located in the tail on the right side between frames Nos. 15-18;

the Freon compressor is mounted between frames Nos. 15-18 in the tail of the aircraft;

a receiver which is also located there;

a filter-drier, also installed in the tail of the aircraft; piping.

The maintaining of the reduced temperature of Freon-12 is accomplished by its evaporation (the boiling) in an evaporator at the appropriate pressure with the continuous removal of vapors being formed. The heat removed by Freon-12 from the cooled air is transferred in the condenser to the air being removed from the aircraft.

After cooling the vapors of Freon-12 are collected in the condenser and then in a liquid state again enter the evaporator.

The turning on of the conditioner is accomplished with the help of the AZS-10 on the central panel. The lamp for signalling of the on position of the conditioner is located on the instrument panel.

The electrical circuit of the conditioner is given in Fig. 173.

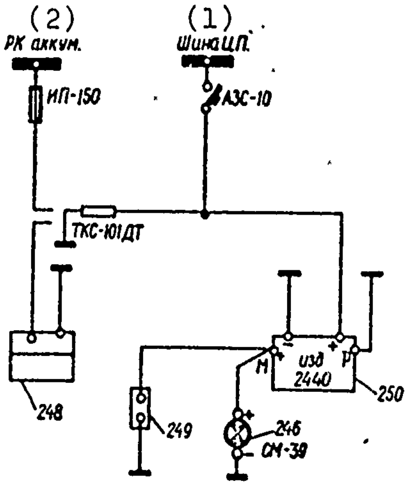

Fig. 173. The electrical circuit for inclusion of the airborne conditioner: 249 - electromagnetic coupling of compressor; 250 - conditioner evaporator; 248 - electric motor of the compressor of the conditioner; 246 - lamp for signalling of the turned on position of the conditioner (green).

KEY: (1) Busbar, TsP; (2) RK of storage battery.

Basic technical data for the conditioner

Productivity, cal/h......................	2000
The rate of air flow at an input temperature of +35°C, kg/h.........	400

The temperature of the cooled air at the outlet, °C	no more than 20
Atmospheric pressure on the outlet of the evaporator, atm	1
Expenditure of the cooled air being controlled manually, kg/h	300-400
Time of continuous operation, h	no more than 3.5
Pressure of Freon-12, atm:	
at the input to the compressor	2.75
at the compressor outlet	14.2

In practice the conditioner begins to cool normally only in 5-7 min after switching on. Before switching on the AZS-10 of the conditioner it is necessary to turn on the fan of evaporator by rotation of the rheostat on the evaporator unit (left handle). The expenditure of air is regulated by the same rheostat. If necessary the air temperature at the outlet from the evaporator can be controlled by rotation of the handle of the regulating valve located on the right side of the evaporator panel.

DV-302T Fan

The DV-302T fan is installed in the canopy of the left side and is fastened on a hinge so that the airflow can be directed by the pilot to the desired side. The fan is turned on with the help of the AZS-2 on the left panel.

The Electromagnetic Switch for Locking the Rear Wheel

The electromagnetic switch for locking the rear wheel (part 1343) installed along the axis between frames Nos. 22 and 23. It serves for locking the rear wheel when taxiing in a cross wind and is switched on with the help of an AZS-5 on the central panel of the instrument panel. The AZS-5 is covered by a cap made from plexiglass.

Next to the AZS-5 is a red signal lamp SM-39 in an SLM-61 armature. The lamp lights up when the rear wheel is in the locked position.

Control of Agricultural Equipment

Control of the actuating devices of agricultural equipment is electropneumatic and is accomplished by remote control.

The electrical diagram for control of agricultural equipment is given in Fig. 174.

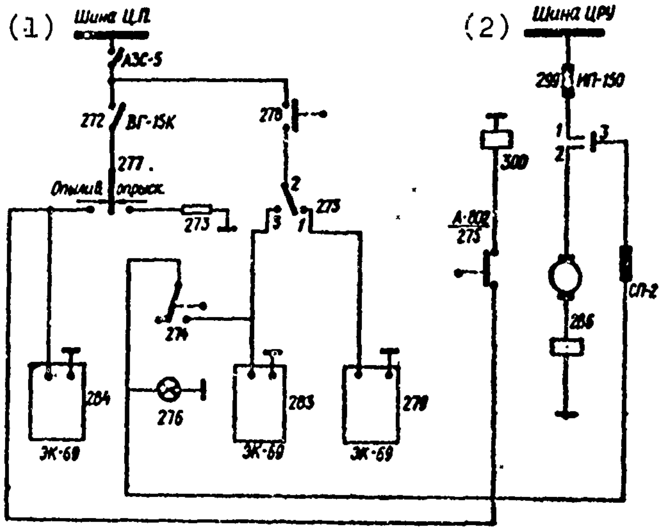
(1)
Шина ЦП
АЗС-5
272
ВГ-15К
278
277.
Опылив.
опрыск.
2
275
3
1
273
274
276
284
ЭК-69
283
ЭК-69
279
ЭК-69
(2)
Шина ЦРУ
299
ИП-150
1
3
2
300
А-802
275
286
СП-2

Fig. 174. Basic electrical circuit for control of agricultural equipment: 273 - relay TKD-12 PD for turning on the valve of the sprayer; 274 - terminal switch DP-702 of the signal lamp; 278 - terminal switch DP-702; 279, 283, 284 - electropneumatic valves 3K-69.

KEY: (1) Busbar TsP; (2) Busbar TsRU; (3) Duster; (4) Sprayer

The equipment can work in the mode of dusting as well as in the mode of spraying.

Dusting

The stirring of granulated and powdered fertilizers and toxic chemicals is accomplished by a stirrer which is driven by a quadripole series-wound D-2500A1 electric motor through a reduction gear.

Basic technical data for the D-2500-A1

Supply voltage, V......................	24-28
Current consumed, A....................	170
Power, W...............................	2,950
Moment on shaft, kgf.cm................	107
Rotative speed, rpm....................	2,300
Time of continuous service, min.........	1
Break between switching on, min.........	no less than 1.5
The number of inclusions with 1.5 min breaks................................	4
Service life (switching ons)...........	2,500
Weight, kg.............................	11.6

The cylinder of the lock of the measuring hopper is opened with the help of the EK-69 electropneumatic valve.

Operation of Electrical Circuit

For the carrying out of dusting it is necessary:

a) to turn on the AZS-5 on the central panel with the inscription "Agricultural equipment";

b) to turn the function selector (pos. 277) PPNG-15 on the right panel of the instrument panel with the inscription "Dust-Spray" to the "Dust" position;

c) when approaching the run to turn on hermetic switch VG-15K (pos. 272) on the control wheel. With this the voltage of the aircraft electrical system from the busbar of the central panel through AZS-5 switch VG-15K, and switch PPNG-15 enters the electropneumatic valve EK-69 (pos. 284) of the lock cylinder which opens the measuring hopper.

Simultaneously with the opening of the lock cylinder contacts of terminal switch A-802 are closed, the contactor TKS-201D1 (pos. 300) located in the TsRU is triggered and the D-2500-A1 electric motor for the stirrer is turned on. Simultaneously the signal lamp (pos. 276) on the left panel of the instrument panel lights up. The stirrer operates. Chemicals or fertilizers are supplied through the measuring hopper to a three-channel pulverizer and are pulverized by the airflow.

When the run is made it is necessary to disconnect the VG-15K switch on the control wheel and the equipment is disconnected and the lamp goes out. The AZS-5 and the function switch are turned off only after the termination of flights.

Spraying

For carrying out spraying it is necessary:

a) to switch on the AZS-5 on the central panel with the inscription "Agricultural equipment;"

b) to place the function selector (pos. 277) in the "Spray" position;

c) when approaching the run to switch on the VG-15K switch on the control wheel.

The voltage of aircraft electrical system is fed from the busbar of the central panel to relay TKD-12PD (Fig. 174, pos. 273) and the relay responds.

Because of the pressure of liquid chemicals in the pipeline contacts 3 and 4 of terminal switch DP-702 (pos. 278), installed under the floor between frames Nos. 1 and 2, will be in a locked position. The voltage of the aircraft electrical system is fed from the busbar of the central panel to electropneumatic valve EK-69 of the sprayer cylinder. The latter is triggered and liquid chemicals are supplied under pressure to the rods of the sprayer.

On the cylinder head of sprayer terminal switch A-802-D (pos. 274) is installed. It simultaneously switches on the signal lamp (pos. 276) on the left panel of the instrument panel.

When the run is made it is necessary to disconnect the switch on the control wheel, the signal lamp goes out, relay TKD-12-PD is switched off, and its disconnecting contacts 1 and 2 supplies voltage to the electropneumatic valve EK-69 for sucking chemicals out of the pipeline (pos. 279). When the pressures of liquid chemicals in the pipeline are gone then contacts 3 and 4 of terminal switch DP-702 (pos. 278) are opened and electropneumatic valve EK-69 for sucking chemicals from the pipeline is disconnected.

§ 41. RADIO EQUIPMENT ON THE An-2M AIRCRAFT

The An-2M is equipped with the following radio equipment:
short-wave communications radio set R-842;
command VHF radio set;
automatic radio compass ARK-9;
radio altimeter RV-U.

When using the agricultural equipment on the aircraft the R-842 radio sets and ARK-9 radio compass should be removed from it.

The arrangement of units of radio equipment is shown in Fig. 175.

The power supply of radio equipment during flight is accomplished from d-c sources: the VG-7500 generator and 12SAM-28 storage battery, and by alternating current with a voltage of 115 V and frequency 400 Hz - from the PO-250 converter.

The protection of circuits of power supply for radio equipment in the d-c circuits is accomplished with the help of the AZS automatic protection network. The circuits for feeding the continuous current of converters are protected by the inertial fuses of the type IP-50. Besides the fuses of the AZS type in circuits for powering the radio equipment there are also safety fuses of the type SP, located directly in the equipment.

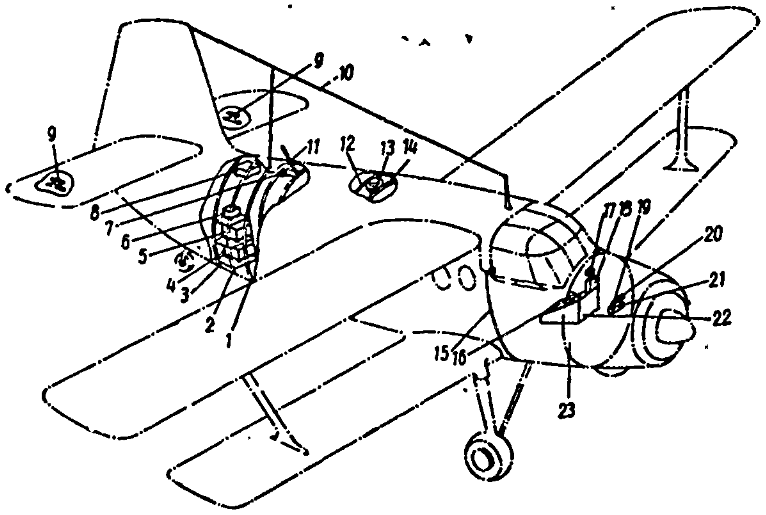

Fig. 175. The arrangement of units of radio equipment on the An-2M: 1, 2, 3 - Frames Nos. 17, 18, 19; 4 - Transceiver RV-U; 5 - Receiver ARK-9; 6 - Transceiver of VHF radio set; 7 - Antenna unit ARK-9; 8 - Transceiver R-842; 9 - Antenna RV-UM; 10 - Antenna for radio set R-842; 11 - Antenna AMS-1; 12, 14 - Frame No. 5; 13 - Plug for tank; 14 - Connection box; 15 - Frame No. 3; 16 - Panel for remote control of VHF radio set; 17 - Remote-control switch for ARK-9 waves; 18 - Control panel ARK-9; 19 - Switch for signal altitude PSV-UM; 20 - Altitude indicator UV-57; 21 - Panel for remote control of radio set R-842; 22 - Central panel of pilot; 23 - Frame No. 2.

Command VHF Radio Set

The command radio set is an ultrashort-wave receiving-transmitting simplex radio-telephone station intended for communications between the aircraft and the airports and also for the plane-to-plane communication during flight.

The transceiver of the VHF radio set with a shock-absorbing mount is installed in the tail of aircraft on a set of shelves between frames Nos. 18 and 19. The panel for remote control is located on the central control panel of the pilot.

Fuses for the radio set:

1) the AZS-5 is located on the central panel in the general circuit of power supply for the radio set;

2) the fuse of the type VP-1 on 5 A (small-size) is located on the transceiver. It is installed in the power circuit of the transceiver, converter, and mechanism for the collection of channels (MNK). If it burns out, then neither the transceiver nor the MNK work;

3) the fuse of the type VP-1 on 3 A stands in the circuit of the transceiver and converter. If it burns out, then the MNK mechanism will switch channels, but transceiver will not work.

Communications Radio Set R-842

The R-842 radio set is a short-wave receiving-transmitting simplex exchange set intended for communications between the aircraft and the ground and between aircraft. The radio set is tuned by a technician on the ground on assigned channels and makes it possible to use any channel for communications enroute. Frequencies are stabilized by quartzes, thanks to which search-less and tuningless communications is ensured.

The transceiver with the rectifier unit is installed on a set of shelves in the tail between frames Nos. 18 and 19. The panel for remote control is located on bracket on the right side of the pilot's central panel.

The beam antenna is a cable 6920 mm in length. The antenna is suspended between the fin and a mast mounted on the upper covering of aircraft at frame No. 5. The antenna is detachable.

Automatic Radio Compass ARK-9

The ARK-9 automatic radio compass is intended for air navigation on homers, radio broadcasting stations [ShVRS] (ШВРС), and radio beacons, and also for landing approach using the OSP-N system.

The scheme of the receiver is carried out on miniature parts and semiconductor devices. Control of the radio compass is remote and is accomplished from the DU panel.

The ARK-9 includes (Fig. 176): receiver 1; antenna unit; the panel for remote control 3; power pack 2; remote-control switch of waves 5; loop antenna 6; antenna filter AF-1 7; indicator UGR-1 (from the GIK-1M) 4; antenna for nondirectional reception AMS-1.

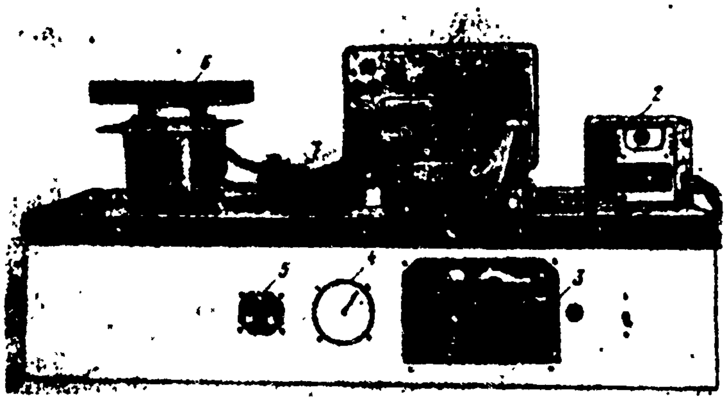

Fig. 176. The ARK-9.

The receiver and the power pack of the radio compass are installed in the tail of the aircraft on a set of shelves between frames Nos. 18 and 19 on the right side. The panel for remote control and the remote-control switch of waves are located on the central panel of the instrument panel. The UGR-1 course indicator is located on the left panel of the instrument panel. The frame of the antenna is installed in the upper fuselage between frames Nos. 10 and 11. The antenna unit is placed behind the AMS-1 antenna between frames Nos. 15 and 16.

Basic technical data ARK-9

Frequency range, KHz	150-1300 (2000-230 m)
Range broken up into four sub-bands, KHz:	
Sub-band I	150-300
Sub-band II	300-600

Sub-band III	600-900
Sub-band IV	900-1300
The accuracy of calibration of the tuning dial of the control panel from the rated value of frequency, %	2.5
It allows tuning	on any two assigned frequencies of range (main and stand-by)
Error of bearing, degree	±3
Sensitivity of receiver, μV:	
on open antenna	10-12
on frame	50
Weight of assembly, kg	19
Operating range on a homing station, km	160-180
ARK-9 normally operates under conditions:	
temperature of surrounding medium, °C	from +50 to -60
maximum air humidity, %	up to 98
pressure which corresponds to the flight altitude, km	20
Current consumed from the aircraft electrical system, A:	
direct current (27 V)	1.5-2
alternating current (115 V, 400 Hz)	1
Power consumed:	
direct current, W	50-60
alternating current, W	75
Overall required power, W	130-140

Control of the ARK-9 Radio compass

The ARK-9 radio compass is controlled from the panel for remote control PDU and the wave switch PVD.

The PDU has (Fig. 177): a function selector "Off-Compass-Antenna-Loop" 1; doubled switches (main and stand-by) 4 and 7 for setting of frequency (coarse tuning); potentiometers (main and stand-by) for fine tuning within the limits of $+20_{-10}$ KHz 6 and 8; Tuning meter 11; switch "TLF-TLG" 9; the volume adjuster 3; button "Control" 10 for the switching of control panels (in the one-board

Fig. 177. ARK-9 control panel.

variant it is not used); the switch for manual rotation of the loop "L-Loop-P" 2; lamp for red illumination 5; the remote-control wave switch (PVD), serving for the rapid switching of the ARK-9 from a distant homing station to a near one (time for returning 5 s).

The presence of main and stand-by tuning together with the switch ensures presetting on two ground-based stations, which facilitates the pilot's work with the compass in the air (for instance, during the determination of a fix, during retuning from a distance homing station to a near one for landing).

The antenna unit is intended for the amplification of the signal and agreement of the non-directional antenna having a large inner resistance, with the lowresistance load. It is the long high-frequency feeder which connects the input of receiver with the directional antenna.

The directional antenna, possessing the property of beam reception, makes it possible to search for the direction of a radio transmitting station to which the receiver is tuned. The degree of turning of the loop is transfered to the radio compass indicator by means of a selsyn system.

The course marker of the radio compass is taken from the assembly of the GIK-1M compass. It shows the course angle of radio station - the angle between the longitudinal axis of the aircraft and the direction to the radio station.

The ARK-9 radio compass can work in three modes:

in the mode "compass" - the pointer of the UGR-1 instrument automatically shows the KUR;

in the mode "Antenna" - the tuning and playback of homing stations takes place;

in the mode "Loop" - it is possible to fix station on the minimum of audibility during the rotation of the loop from the switch "left - right."

Turning on and Tuning the ARK-9

For turning on and tuning the ARK-9 it is necessary:

1. To turn on the AZS-5 with the inscription "ARK-9" on the pilot's central panel.

2. To turn on the PO-250 converter (or PO-500).

3. To set the switch of the radio "KR-UKR" on the central panel of the instrument panel to the position "UKR" and toggle switch "ARK-Off" on the R-860-I control panel - to the position "ARK."

4. To turn on the function selector on the control panel of compass to the position "antenna" and after a certain time a characteristic noise will appear in telephones and the pointer of the tuning meter will depart from zero value.

5. To set the volume adjuster to the position of the maximum or average loudness level.

6. Depending on the mode of operation of the radio station

set the "TLG-TLF" switch in the necessary position.

7. With the decimal frequency switch "KGTs" and the handle for fine adjustment with the help of the indicator accurately tune to the required radio station at the maximum divergence of the pointer of the tuning meter to the right.

8. Set the function selector in the position "Compass", and the pointer of the course indicator will show the KUR.

Tuning the ARK-9 and direction-finding is done with the conditioner turned off, otherwise it increases the interference level and creates errors in the KUR readings.

The order of use of the switch for the manual rotation of the loop is the same as for the ARK-5. Only in the ARK-9 the loop will be rotated from the switch "Left-Right" with any position of the function selector, and not only in the position "Loop."

The ARK-9 has AZS-5 fuses on the central panel and SP-2 in the RK of alternating current with a voltage of 115 V and frequency of 400 Hz.

Radio Altimeter RV-U

The RV-U radio altimeter is intended for the determination of actual height over the terrain from 0 to 600 m. Just as also with the RV-2 the readings of the RV-U do not depend on atmospheric conditions and the cover of the terrain (earth, water, snow, ice).

The RV-U with the PSV-UM switch ensure the sonic and light signalling "dangerous altitude." The principle of operation of the RV-U is analogous to the principle of operation of the RV-2.

The assembly of the radio altimeter RV-U includes (Fig. 178):

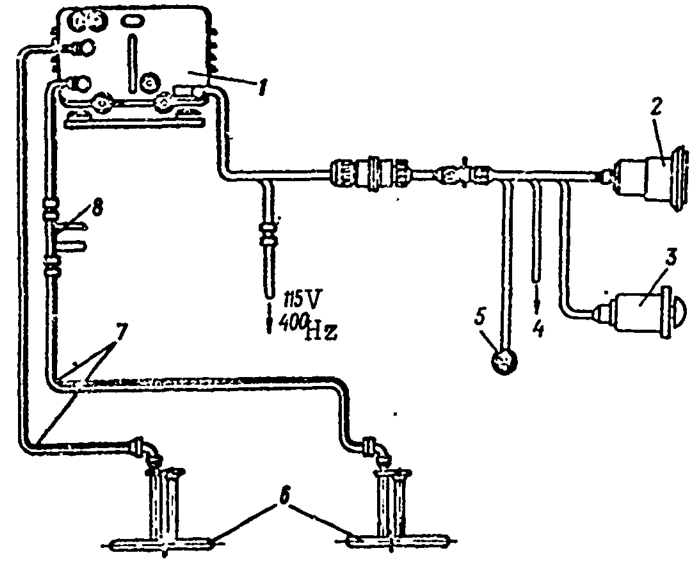

Fig. 178. Assembly diagram of the radio altimeter RV-U.

transceiver PP-UM 1; altitude indicator UV-57 2; switch for signalling altitude PSV-UM 3; outlet for sonic signalling 4; signal lamp "Dangerous altitude" 5; receiving and transmitting antennas 6; high-frequency cable 7; high-frequency filter VChF-3 8.

The transceiver and SChF-3 filter are installed on a set of shelves of the right side between frames Nos. 18 and 19. Altitude indicator UV-57, the signal lamp" Dangerous altitude," and the PSV-UM switch are located on the left panel of the pilot's instrument panel. The transmitting and receiving antennas are mounted on the lower side of the brackets of the stabilizer, between ribs Nos. 11 and 12.

Basic technical data for the RV-U

Measured actual height, m.........	from 0 to 600
Reserve of sensitivity, m.........	900-1000
The accuracy of measurement from the measured altitude, m..........	5-8 ± 8%
Average carrier frequency of transmitter, MHz..................	444 ± 6
Modulation frequency, Hz..........	70

Band of modulation (flutter of transmitter frequency), MHz	444 ± 17 (427-461)
Accuracy of signalling altitudes from their real magnitude, %:	
over the range of altitudes 200-400 m	5-10
over the range of altitudes 50 m	10-20
Radiated power of transmitter, W	0.2
Required power from network of 115 V 400 Hz VA	125
Weight of assembly without cables, kg	11.5

With the help of the PSV-UM switch it is possible to obtain the sound and light signals "Dangerous altitude." With the PSV-UM switch it is possible to establish ahead of time one of the following values of altitude for signalling: 50, 100, 150, 200, 250, 300, 400 m. With a descent to an assigned altitude the signalling lamp "Dangerous altitude" lights up and a discontinuous sound signal with a tone of 400 Hz enters into the telephones and continues for 3-10 s. With the PSV-UM switch turned off the signalling lamp lights up at altitudes which exceed the reserve of sensitivity of the radio altimeter (more than 900-1000 m).

The turning on of the radio altimeter is done with the V-200 switch on the left panel of the pilot's instrument panel with the inscription "RV-U". In this case the PO-250 (or PO-500) converter should operate. After switching on and warm-up it is necessary to check the magnitude and nature of the divergence in the pointer of the UV-57 altitude indicator and the final adjustment of light and sound signalling. The UV-57 reading's should not differ from the readings of the barometric altimeter VD-10 by no more than 1-1.5 divisions.

The sound and light signalling is checked in the following manner:

a) On the ground. The PSV-UM switch of the signalling aparatus for altitude is set in the position "K," and then in the position "50 m" or in any other besides the position "off." In this case the lamp "Dangerous altitude" should light up and in the pilot's headset a discontinuous sound signal with a frequency of 400 Hz should be audible.

b) In flight. With the PSV-UM switch one of the necessary signal values of altitudes is established.

With the descent of the aircraft to the altitude set on the PSV-UM switch for 10 s the sound signal will work and the signal lamp "Dangerous altitude" will light up.

§ 42. INSTRUMENT EQUIPMENT OF THE AN-2M AIRCRAFT

The instrument panel (Fig. 179) consists of three duralumin panels: left, central and right, installed on APN type rubber-metal shock absorbers. All the panels are hinged, they are held in the open position by limiting straps.

Left panel (Fig. 180) is installed on the left side of the cockpit and is intended for the accomodation of instruments, switches and control valves. The panel is riveted to detachable duralumin panels - top and side, is attached to the side of the fuselage with brackets.

Central panel (Fig. 181) is attached to on the cockpit floor by screws between frames Nos. 1 and 2. On the central panel are installed the control handles of the power plant, braking lever of the handle, control switches for flaps, trim tabs and shutters, circuit breaker panel, control panel of the R-860 radio.

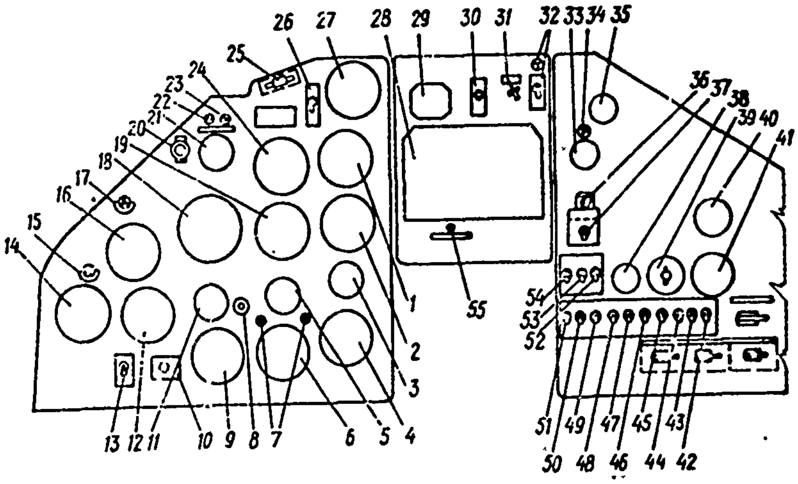

Fig. 179. Instrument panel of An-2M: 1 - MV-16 pressure and vacuum gauge; 2 - 2TTsT-47 thermometer; 3 - TE-45 tachometer; 4 - EMI-3K three-pointer indicator; 5 - TUE-48 carburetor thermometer; 6 - SBES-1447 fuel gauge; 7 - fuel remainder warning lights; 8 - GIK-1 fast adjustment knob; 9 - DIKZh-4 fluid quantity indicator; 10 - gasoline gauge indicator switch; 11 - PSV-UM altitude signalling switch; 12 - UV-57 radio altimeter indicator; 13 - radio altimeter switch; 14 - VD-10 altimeter; 15 - "Dangerous altitude" warning light; 16 - US-35UT speed indicator; 17 - agricultural equipment activation signal light; 18 - AGK-47B gyrohorizon; 19 - VR-10 rate-of-climb indicator; 20 - fire extinguishing control knob; 21 - PM-1 ignition switch; 22 - "Fire warning" light; 23 - "Fire" monitoring light; 24 - UGR-1 gyro induction compass indicator; 25 - "Starter - PNG-15" switch; 26 - AZS-20 of starting circuit; 27 - AChS-1 clock; 28 - control panel of ARK-9; 29 - remote-control switch of ARK-9 waves; 30 - "Aircraft-Airfield" feed switch; 31 - "UKR-KR" radio switch; 32 - tail wheel locking switch and signal light; 33 - A-1 generator direct-current amperemeter; 34 - generator failure warning light; 35 - A-1 aircraft battery direct-current amperemeter; 36 - Regulation voltage generator; 37 - generator switch; 38 - V-1 direct-current voltmeter; 39 - V-1 voltmeter switch; 40 - TUE-48 gear box oil thermometer; 41 - VF-0.4-150 alternating-current voltmeter; 42 - AZS-2 of TUE-48 gear box oil temperature thermometer; 43, 44 - AZS-5 of illumination; 45 - AZS-5 of fuel gauge; 46 - AZS-5 of wing flap and oil cooler shutter position indicators; 47 - AZS-2 of TUE-48 carburetor temperature thermometer; 48 - AZS-5 of oil cooler shutter electric motor power supply; 49, 50 - AZS-5 cowl flap electric motor power supply; 51 - AZS-2 ofEMI-3K; 52, 54 - AZS-5 of upper and lower flap electric motor power supply; 53 - AZS-2 in the flap control circuit; 55 - conditioner activation signal light.

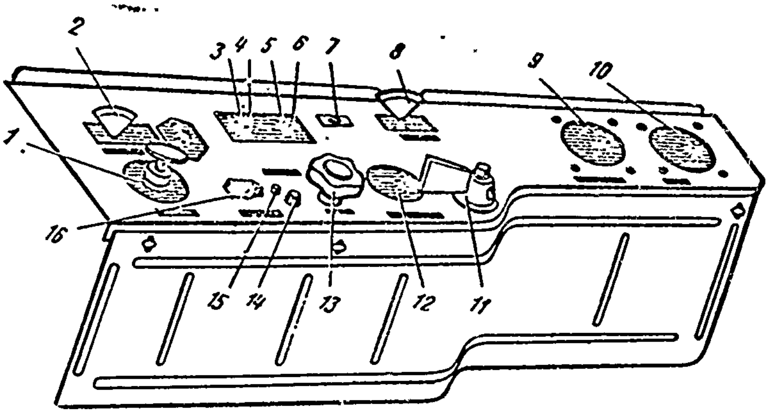

Fig. 180. Left panel: 1 - priming pump; 2 - oil dilution switch; 3 - clock heating switch; 4 - fan switch; 5 - glass heating switch; 6 - windshield wiper switch; 7 - DIKZh-4 measurement switch; 8 - servicing fuel pump switch; 9 - agricultural equipment pneumatic system manometer; 10 - brake manometer; 11 - handle of three-way cock of fuel system; 12 - pneumatic system manometer; 13 - pneumatic system valve; 14 and 15 - light and knob for checking pilot-static tube heating; 16 - handle of panel ultraviolet illumination rheostat.

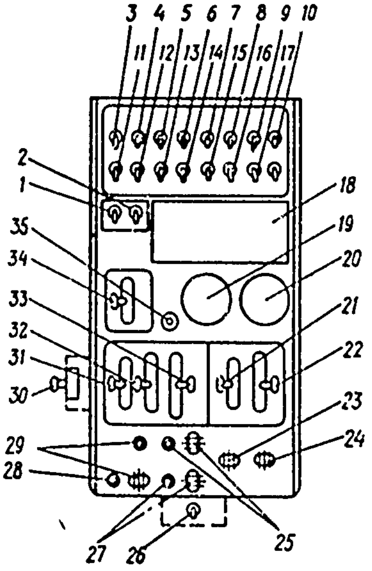

Fig. 181. Central panel: 1 - AZS-5 of taxiing light; 2 - AZS-5 of navigation lights; 3 - AZS-5 of fire-extinguishing system; 4 - AZS-5 of pilot-static tube heating; 5 - AZS-10 of AGK and PT-125Ts; 6 - AZS-5 of VHF radio; 7 - AZS-2 of GIK-1; 8, 9, 10 - AZS-2 of electric motors of elevator and rudder ailerons; 11 - AZS-10 of left headlight; 12 - AZS-10 of right headlight; 13 - AZS-10 of conditioner; 14 - AZS-10 of agricultural equipment power supply; 15 - AZS-2 of PO-250 (or PO-500); 16 - AZS-5 of ARK-9; 17 - AZS-15 of R-842 radio; 18 - control panel of VHF radio; 19 - UZP-47 flap indicator; 20 - UZP-48 oil cooler shutter indicator; 21 - carburetor heating control knob; 22 - engine shut-down handle; 23 - oil cooler shutter switch; 24 - cowl flap switch; 25 - rudder trim tab switch and signal light; 26 - agricultural equipment mode switch; 27 - aileron trim tab signal light; 28 - flap raise knob; 29 - elevator trim tab switch and signal light; 30 - gear box control knob; 31 - altitude mixture control handle; 32 - throttle with flap lowering knob; 33 - propeller pitch handle; 34 - intake pipe filter handle; 35 - door opening warning device.

Instruments Monitoring Engine Operation

The instruments monitoring the engine operation include: EMI-3K three-pointer indicator; SBES-1447 fuel gauge; TUE-48 carburetor thermometer; TUE-48 oil thermometer of KPM gear box; 2TTsT-47 cylinder head thermometer; TE-45 tachometer; MV-16 pressure and vacuum gauge.

Flight and Navigation Instruments

On the An-2M aircraft there are the following flight and navigation instruments: VD-10 altimeter; US-35UT speed indicator; VR-10 rate-of-climb indicator; KI-13 compass; AGK-47B gyrohorizon; GIK-1 gyro induction compass; AChS-1 clock; AD-2 barograph; TV-45 free air temperature gauge.

Figure 182 depicts the assembly diagram of gyro induction compass GIK-1. The supply system of diaphragm - aneroid instruments (Fig. 183) ensures the supply of static and total pressures to the following instruments: the VD-10 altimeter, the US-35UT speed indicator, VR-10 rate-of-climb indicator, P-16 receiver of the fuel pressure gauge.

The supply system consists of the lines of static and total pressures, being supplied from one PVD-6M pitot-static tube, which is installed on the left biplane strut.

For preventing the accumulation of moisture in the total and static pressure lines and its getting into diaphragm - aneroid instruments at the lowest point of the lines moisture traps are installed. Access to the moisture traps is accomplished through hatches, located in the left lower covering of the wing center section of the fuselage.

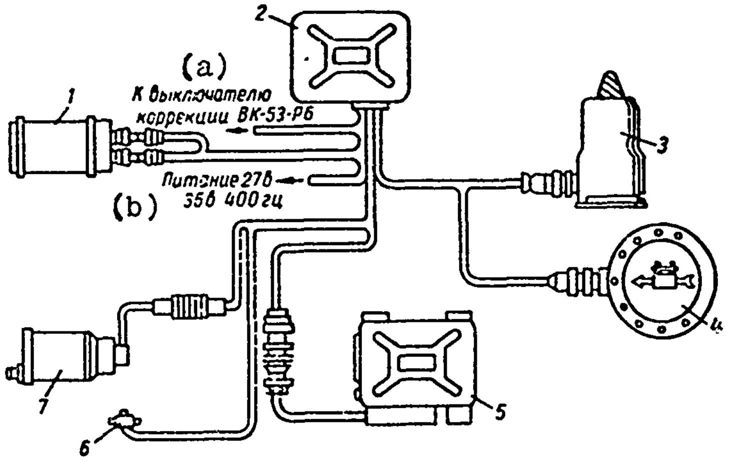

Fig. 182 - Assembly diagram of GIK-1: 1 - KM erecting mechanism; 2 - SK-11 connection box; 3 - G-3M gyro unit; 4 - ID induction pickup; 5 - U-6M amplifier; 6 - 5-KS adjustment knob; 7 - UGR-1 indicator.

KEY: (a) To VK-53-R6 erecting switch; (b) 28 V power supply, 35 V 400 Hz.

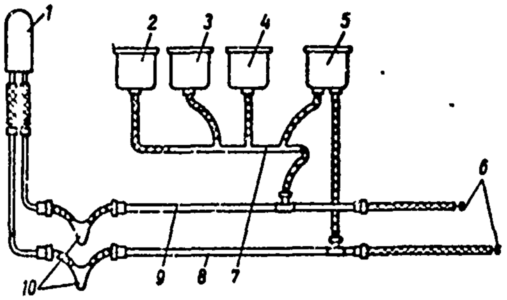

Fig. 183 - Schematic of the connection of instruments to the pitot-static tube: 1 - PVD-6M receiver; 2 - VR-10 rate-of-climb indicator; 3 - P-16 receiver of the fuel pressure gauge; 4 - VD-10 altimeter; 5 - US-35UT speed indicator; 6 - plugs; 7 - distributor; 8 - total pressure line; 9 - static pressure line; 10 - moisture traps.

Auxiliary Instruments

Auxiliary instruments include: two type A-1 direct-current amperemeters with ShA-46 shunt; type V-1 direct-current voltmeter with switch; VF-0.4-150 alternating-current voltmeter; UZP-47 and UPZ-48 indicators; manometers; DIKZh-4 fluid quantity gauge.

The A-1 amperemeter, installed in the upper part of the right panel of the instrument panel, is included in the load circuit of the 12SAM-28 aircraft battery (or airport power source). The amperemeter is designed for monitoring the current of the users from these power sources.

The A-1 amperemeter, included in the circuit of the VG-7500 generator, is intended for monitoring the power consumption on the direct-current network in flight. The amperemeter is installed on the right panel of the instrument display.

The V-1 voltmeter together with the switch at four positions is intended for monitoring the voltage at various points of the circuit: "Battery" - voltage at the terminals of the aircraft battery (or the airport power source); "TsRU" - voltage on the busbar of the central distribution system; "G_1" - voltage at the generator terminals.

The VF-0.4-150 voltmeter serves for monitoring voltage 115 V 400 Hz, which enters the busbar of alternating - current RK from the PO-250 (or PO-500) converter.

On the left pilot's panel there are installed three pneumatic system manometers: one - in the overall system, the second - in the pneumatic system of the argicultural equipment and the third - in the brake system.

The DIKZh-4 fluid quantity gauge (Fig. 184) serves for measurement of the level of liquid chemicals with their loading into a tank and with expenditure in flight.

The DIKZh-4 assembly includes: two DIKZh-U indicators, one of which is installed on the left panel of the instrument display, and the second - on the servicing panel; DIKZh-D transmitter; DIKZh-T transformer.

The transmitter is of manometric type. With change in the level of liquid in the tank the diaphragm of the transmitter caves

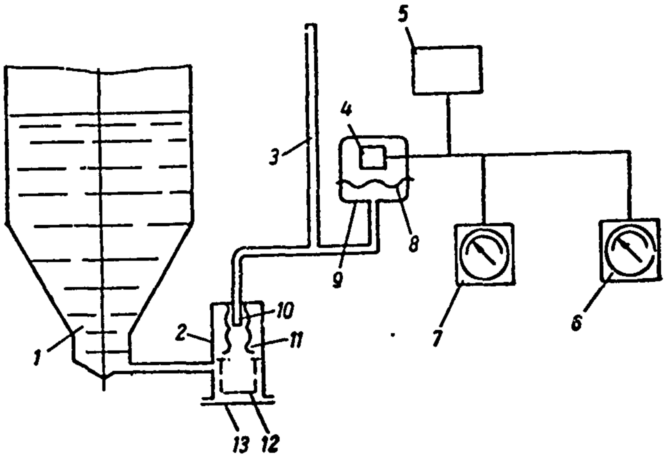

Fig. 184. Schematic diagram of the DIKZh-4 fluid quantity gauge: 1 - tank for chemicals; 2 - housing of filter-damper; 3 - drain pipe; 4 - magnesyn of transmitter; 5 - DIKZh-T transformer; 6 - pilot's DIKZh-U indicator; 7 - DIKZh-U indicator on the servicing panel; 8 - transmitter diaphragm; 9 - DIKZh-D transmitter; 10 - throttle; 11 - rubber damper; 12 - gauze filter; 13 - filter cover.

in. The deflection of the diaphragm through the system of magnesyns is transferred to the pointers of the indicators, the scale of which is calibrated in liters.

The power supply of the instrument is accomplished by the alternating-current aircraft electrical wiring system with voltage 115 V, which is reduced by the DIKZh-T transformer to 26 V.

For preventing the influence of variation of liquid in the tank on the diaphragm of the transmitter, before it a damper is installed, which is a rubber bellows, shielded by a gauze filter.

CHAPTER VIII

AGRICULTURAL EQUIPMENT

§ 43. GENERAL INFORMATION

The An-2 aircraft series 37-11 is equipped with special agricultural equipment for its use as an agricultural variant. For this purpose spaces have been provided in the aircraft for the installation of agricultural equipment, and also hermetically sealed hatches and fairings.

The An-2 aircraft in the agricultural variant is used for the following purposes:

dealing with harmful insects, rodents, diseases of plants, and weed infested vegetation;

the feeding of agricultural crops with mineral fertilizers;

the early removal of leaves and acceleration of ripening of the balls of cotton plants;

the aerial sowing of a forest (seeds of saksaula and coniferous species);

the blackening of snow for the purpose of accelerating its thawing and for other operations.

The agricultural equipment installed on an aircraft, depending on the chemicals used, is manufactured in two variants:

1) duster - for loose chemicals (Fig. 185);

2) sprayer - for liquid chemicals (Fig. 186).

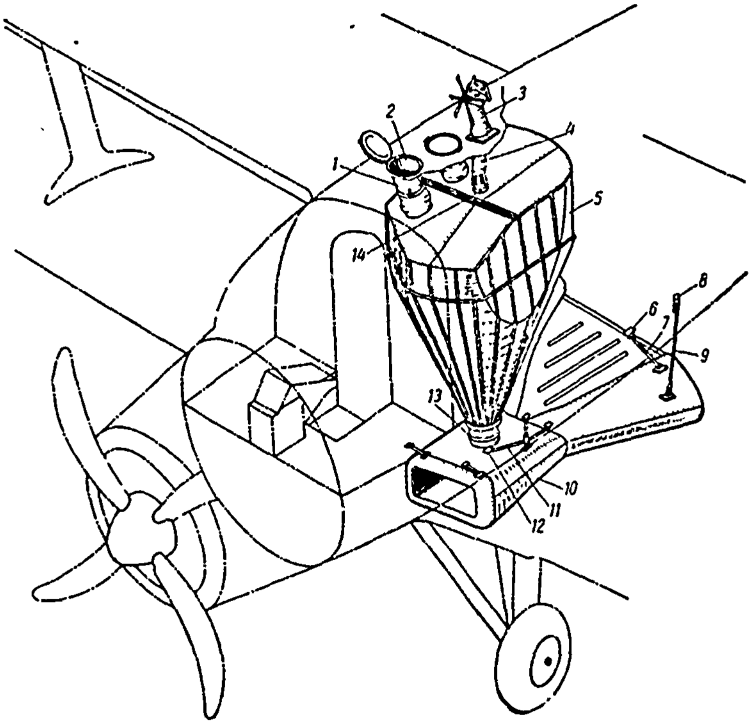

Fig. 185. Schematic of the installation of duster (issue 1959-1962): 1 - loading pipe; 2 - cargo hatch; 3 - air vanes; 4 - case; 5 - tank for chemicals; 6 and 8 - brackets; 7 and 9 - rods; 10 - tunnel sprayer; 11 - support; 12 - bracket; 13 - vent of tank; 14 - shaft of agitator.

Agricultural equipment in the process of production underwent four basic design changes in issues from 1955 through 1962.

During every issue in the equipment there were also some design improvements (especially in the issue of 1955).

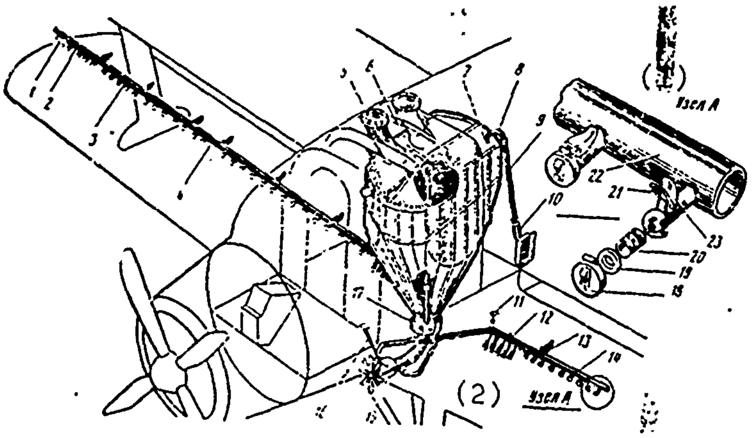

Fig. 186. The layout of the sprayer: 1 - attached tube; 2 - padding; 3 - cantilever rod; 4 - connection of rods; 5 - filter; 6 - attachment of hydraulic agitator inside tank; 7 - attachment of elbow of filling tube to tank; 8 - elbow; 9 - tube; 10 - check valve of filling tube; 11 - bracket; 12 - connecting tube; 13 - stopping pin; 14 - cantilever rod; 15 - pumping unit SH7609-500; 16 - bracket for attachment of pumping unit to fuselage; 17 - attachment of pumping unit to vent of tank. Unit A (attachment of jets to fittings of rods); 18 - jet; 19 - washer; 20 - valve; 21 - eccentric lock; 22 - rod; 23 - fitting.
KEY: (1) Unit A.

The equipment of the 1956 issue has the following distinctions from the equipment of previous issues:

1) manual mechanical control of equipment is replaced by pneumatic and is accomplished by compressed air from the airborn pneumatic system of the aircraft;

2) the construction of the metering vent and gates has been changed;

3) a tunnel sprayer has been perfected by means of the installation of air intakes for the additional blowing out of sleeves and cuts have been made underneath the sleeves;

4) the worm reducer of the air vane is made with a globoid engagement and has been adapted for liquid lubrication;

5) the spring rippers of the agitator have been made triple a rigid ripper and scraper have been installed;

6) the adjustment of agitator shafts along the length is done by a threaded connection in the connecting shaft;

7) the repair hatch of the tank has been transferred from the upper lid to the side wall behind the tank;

8) the observation glass and the windshield wiper of the tank are replaced by a readily detachable eyepiece, and electrical illumination of the tank is replaced by the transparent covers of cargo hatches;

9) a grid is installed in the loading sleeves;

10) the construction of the check valve of the refueling tube for reloading the tank with liquid chemicals has been changed;

11) the scale of the hydraulic agitator has been carried out by individual figures and the calibration table has been removed from the tube of the hydraulic agitator;

12) in the sleeve of the underwing rods check valves are installed which cut off the wave of liquid when the pumping unit is switched off;

13) the intake valve on the pumping unit has been removed.

The equipment of the 1957 issue unlike the equipment of the 1956 issue has the following basic changes:

1) in the tunnel sprayer a central (third) channel has been introduced for the uniform distribution of chemicals over a surface;

2) the construction of the points of attachment of the tank for chemicals to frame No. 8 has been changed and an additional point of attachment of the tank to frame No. 7 on the left side has been introduced;

3) under the flange of the vent of the tank a cup with tube is installed for the draining of liquid over the side (in the case of leaking of the tank during operation);

4) the construction of the sealing of the gates of the metering vent has been changed;

5) end switches KV6-2A are replaced by VK2-142G and they are installed outside on the upper duct of the metering vent.

In the subsequent issues of 1958 and 1959-1962 the agricultural equipment has a further improvement of construction.

The An-2 aircraft in the agricultural variant of series 115-05 is equipped with a special installation for spraying highly toxic chemicals (of the type mercaptophos). The installation for spraying of highly toxic chemicals is based on the principle of a separate supply of water from the tank of the sprayer and concentrated product from the tank for the chemicals, extended outside the aircraft, with the subsequent mixing of components in a pumping unit.

The pumping unit is additionally equipped with the following units:

a through spigot for covering the main line which feeds the pump with toxic chemicals;

a measuring device for controlling the supply of chemicals and ensuring the required emulsion concentration;

a check valve, a protection from the entry of chemicals into the tank with water;

a drain cock.

In the present chapter the description of the construction of the units of the duster and sprayer is compiled relative to the agricultural equipment of 1959-1962 issue.

The complete set of the duster (see Fig. 185) includes the following basic units:

tank with loading sleeves and agitator;

upper air van with worm reducer and braking device;

tunnel sprayer with metering vent and disk.

The complete set of the sprayer (see Fig. 186) includes the following units:

the same tank with filling tube and hydraulic agitator; a pumping unit with a lower air vane, braking device and measuring hopper;

underwing rods with discharge adapters equipped with the OZh-2 device;

extension tank for highly toxic chemicals.

Control of the duster and of sprayer is general, i.e., is accomplished by the same pneumatic valve.

§ 44. THE BASIC PERFORMANCE DATA

Duster

Tank capacity, *l*	1400
Material of tank	stainless steel
Diameter of air vane, mm	560
Number of blades on air vane.....	6
Operating number of revolutions of air vane, rpm	3000
Power of air vane, hp	5
Type of brake	band
Gear ratio from air vane to shaft of cultivator	40:1
Type of ripper	spring
Number of revolutions of the proportioning disk, rpm	75
Control system for the supply of powder	disk
Type of sprayer	tunnel, three-channel
Control of duster	pneumatic
Atmospheric pressure in the system of duster, kgf/cm^2	16
Time of opening and closing of gates, s	1-1.5
Expenditure of air for one opening of gates, atm	2-3
Time of the expenditure of air, s	50-60
Maximum expenditure of fertilizer, kg/s	up to 20
Width of operating swath, m	from 20 to 80
Weight of the complete set of duster, kg	up to 140

Sprayer

Tank capacity, *l*	1400

Diameter of air vane of pump, mm	580
Number of blades on the air vane of the sprayer	8
Operating number of revolutions of air vane, rpm	3200
Power of air vane, (hp)	8
Type of pump	water pump from AM-42
Operating number of revolutions of wheel of pump, rpm	3200
Pressure in the sprayer pump, kgf/cm^2	3
System for spraying of liquid	rod with single sprayers
Span of rod, m	15.2
Number of sprayers	78-80
Method of the displacement of suspension	hydraulic
Control of sprayer	pneumatic
The atmospheric pressure of the sprayer system, kgf/cm^2	10
Time of opening and closing of valve, s	1-1.5
The rate of air flow for one valve opening, atm	2.5
Time for replenishment of spent air, s	50-60
The maximum expenditure of chemicals, l/s	18.5
Width of working swath, m	up to 60
Weight of the complete set of sprayer, kg	no more than 130

§ 45. DESCRIPTION OF THE CONSTRUCTION OF UNITS

The tank for chemicals (Fig. 187) consists of an outer frame made from steel angle irons with a thickness of 1.5 mm, and a skin made from stainless steel with a thickness of 0.5 mm. The angle irons are welded to the skin by spot electric welding, and the junctions of skins are welded by roller electric welding. The two halves of the tank are riveted with copper rivets and for airtightness on the rivet joints the tank is soldered with POS-40 solder.

Fig. 187. Tank for chemicals of 1957-1962 issue: 1 - filling tube; 2 - repair hatch; 3 - unit for fastening tank to the frame of the fuselage; 4 - eyepiece; 5 - flange of the vent of the tank; 6 - vent of tank.

In the upper part the tank has the form of a cylinder cut off from the sides, and in the bottom part - the form of a cone with an angle of 50°. In the front cylindrical part of the tank from the side of the cockpit there is an eyepiece, mounted in a crimped rubber diaphragm, for the inspection of the inner surface of the tank. The readily detachable lock of the eyepiece makes it possible to remove the eyepiece rapidly and to wipe the glass. For lighting up the tank the covers of the loading hatches are made transparent.

In the upper lid of the tank there are windows with covers for the entry of loading sleeves, an opening for the passage of the connecting shaft of the agitator, and an opening for the connection of the flange of the loading tube. In the rear upper part of the tank there is a repair hatch, through which the installation of the agitator is carried out.

The outlet of the filling tube for filling with liquid chemicals is made on the left side of the fuselage at frame No. 10 and ensures the connection of the fire sleeve with 2.5 inch (or 2 inch) ROT nut with the help of a special adapter. In the main filling line a check valve has been installed which prevents the discharge of the liquid which remains in the tube after filling of the tank with liquid chemicals. Filling is done through a filter accompanying the complete set of equipment.

In the variant of duster on the ROT nut of the filling tube an air intake is put on for drainage of the tank. In the transport variant the niche of the filling tube is covered by a cover.

On aircraft produced prior to 1957 the tank is fastened in the fuselage with the help of two forked bolts to the brackets of frame No. 8, one strut to the bracket of frame No. 6 and by six bolts on the flange of the vent of the tank to the floor. During operation cracks were observed in frame No. 8 at the points of attachment of the tank. For the elimination of this defect on aircraft produced in 1957 the tank for chemicals is fastened with the help of shackles with rubber shock absorbers by two forked bolts to brackets on frame No. 8 and by one forked bolt - to the bracket on frame No. 7 (on the left side), by one brace - to brackets on frame No. 6, and by six bolts on the flange of the vent of the tank - to the floor. Under the flange of the vent of the tank a cup with a drainage tube is installed for the runoff of liquid from the chemicals over the side in the case of leaks in the tank.

During operation cracks appear on the tanks for chemicals and in most cases at the radii of bending of plates at the welds which connect the halves of the tank.

The metering vent (Fig. 188) is a continuation of the tank and serves for the metering of chemicals and covering the feeding of chemicals into the tunnel sprayer from the tank. The gates of the metering vent are moved in a steel stamp housing with the help of pneumatic cylinders.

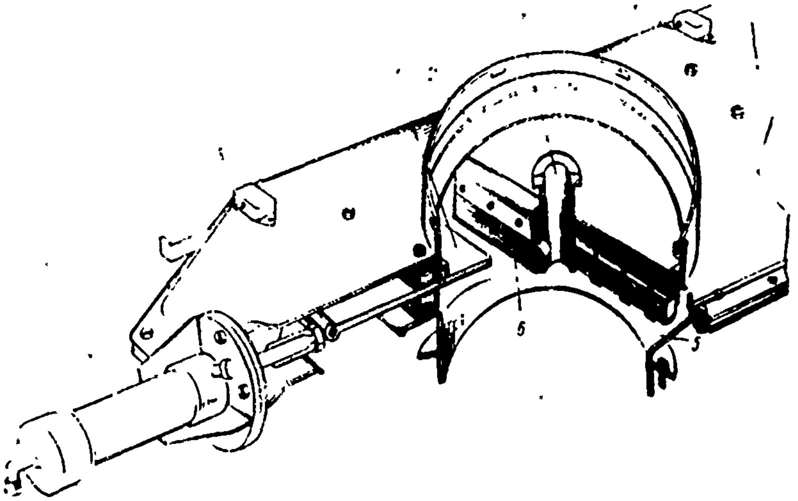

Fig. 188. The metering vent: 1 - gate; 2 - cylindrical casing; 3 - sleeve with ball bearing; 4 - upper duct; 5 - lower duct; 6 - rubber buffer; 7 - pneumatic cylinder; 8 - end switch.

For averting the leakage of powder the vent is hermetically sealed with the help of special labyrinth profiles which are pressed by screws to the gate on the entire width underneath and above, and a rubber buffer, into which the gates are thrust in the closed position. In the bottom part the flange is welded to the vent with six bolts for securing it to the tunnel sprayer.

In the vent there is a transverse tube for securing the rubber buffer of the gates underneath, and on top on the tube in the center of the vent there is a ball bearing for the agitator shaft. The metering vent has VK2-1421 end switches for tubes SLTs-51 for signalling of the open and closed position of the gates. With both gates open a red light lights up on the control panel and with the gates closed - a green.

Agitator. Mounted inside the tank in its lower part is an agitator (Fig. 189) with springs and rigid rippers which works from the air vane through a worm reducer and connecting shafts.

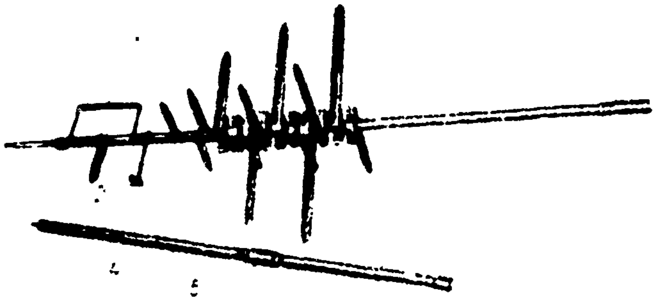

Fig. 189. Agitator with springs and rigid rippers: 1 - scraper; 2 - rigid rippers; 3 - springs; 4 - connecting shaft; 5 - point for regulating the shaft for length.

The shaft of the agitator is made from Cromansil tube with a diameter of 28 × 24 mm with triple leaf springs made from U9A carbon steel of variable length fastened on it with the help of bolts. The springs are arranged at an angle of 90° to one another, forming a cone in the outline of rotation. The lower short springs are made from steel with a thickness of 1 mm, are thermal processed to $\sigma_{\text{вр}} = 44\text{-}48$ kgf/mm^2, and are fastened directly to the shaft. The upper long springs are made from steel with a thickness 1.2 and 1.5 mm, are thermal processed to $\sigma_{\text{вр}} = 44\text{-}48$ kgf/mm^2, and are fastened to the shaft with the help of clamps. In the lower part of the agitator there is a rigid ripper and a scraper.

The shaft of the agitator in its upper part terminates in a slot into which the shank of the connecting shaft enters. The second end of the connecting shaft is connected with the help of a key to the cylinder of the hub of the worm gear of the reduction gear on the air vane.

For control of length the connecting shaft consists of two parts which are connected with the help of a thread. Their junction point is located over the tank and is locked with a bolt.

The shaft of the agitator in its lower part has a seat under the spherical support of the metering vent through which the pin of the metering disk is installed. The square part of the pin enters the supporting sleeve of the agitator and it is fastened to it by the lower bolt of the bracing of the rigid scraper.

The metering disk (Fig. 190) serves for the feed control of powder-like chemicals into the tunnel sprayer. It consists of two conical disks with windows and a hub made from stainless steel. The upper disk is attached to the hub and the lower is pressed to it by wing screws. The disks can be turned relative to one another, due to which the degree of opening of the windows is governed.

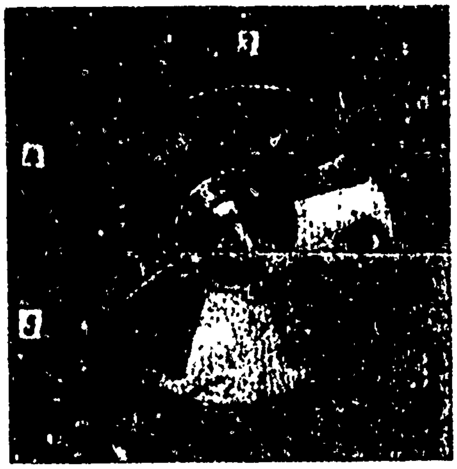

Fig. 190. The metering disk: 1 - upper disk; 2 - lower mobile disk; 3 - hub; 4 - wing screw; 5 - handle of the lower disk.

In the upper part the hub has a square opening, and in the bottom part - an inner thread. The hub together with the disk is seated on the square rod of a pin and rotates together with the shaft of the agitator.

The expenditure of chemicals is governed by a change in the distance between the lower part of the metering vent and disk by means of the movement of the disk over the pin, and by the degree of opening of the windows on the disk. The regulation of the expenditure of chemicals is done before take-off.

The air vane (Fig. 191) is mounted on the upper fuselage and it serves for the rotation of the agitator. It consists of the air vane screw, a steel column, worm reducer, band brake for the air vane, and pneumatic brake control. When the brake is released the air vane is rotated from the jet of the air current.

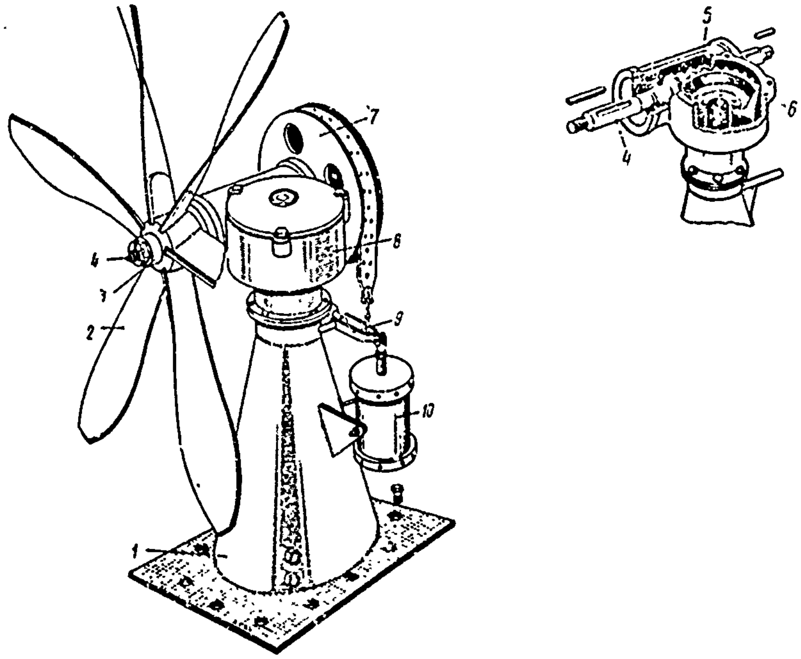

Fig. 191. Air vane with reduction gear: 1 - column of air vane; 2 - air vane; 3 - nut-puller; 4 - shaft of worm; 5 - worm; 6 - worm gear; 7 - brake pulley; 8 - housing for worm reducer; 9 - brake lever; 10 - pneumatic cylinder.

The screw of the air vane consists of six stamped blades made from Cromansil steel with a thickness of 2.5 mm. They are riveted and welded at the thick end to the Cromansil strips of the hub. The screw of the air vane is fastened to the conical shank of the worm of the reduction gear with the help of a key and a special lock nut which is locked. At the second end of the air vane a brake drum is installed on a key.

The worm pair consists of a globoid worm made from Cromansil steel and a worm gear which consists of the bronze rim attached by bolts to a hardened Cromansil hub with a key under the shank of the connecting shaft of the agitator.

The globoid transmission makes it possible to increase the transferred power by 2-2.5 times, and sometimes even 4 times as compared with the conventional worm drive at equal overall sizes. For lubrication of the reduction gear the housing is filled up with cylinder oil 52 (VAPOR) GOST 6411-52. For oil drain into the housing of the reduction gear underneath a drainage plug is screwed in. For controlling the oil level when filling there is a lateral plug in the wall of the housing. Oil is poured through an opening in the cover of the reduction gear. It is closed by a plug.

Lubrication of the worm pair of the reduction gear is accomplished by oil which is poured into the housing of the reduction gear. For averting the leaking of oil on the shaft of the worm packing glands of the sealing ring type are installed, and on the roller of the hub - felt packing gland. Oil can be poured through plugs which are located in the upper and bottom parts of the housing.

On the column of the air vane in a bracket a pneumatic cylinder is installed which rocks freely in the pins of the bracket. The bracket of the rod of the pneumatic cylinder is connected through a lever with the brake bank which has an asbestos gasket.

The tunnel sprayer (Fig. 192) is a three-channel receiver of chemicals which ensures the blowing through of chemicals during flight of up to 20 kg/s. The tunnel sprayer is of riveted construction and consists of an inner channel, an external fairing, and one detachable sleeve.

The inner channel and sleeve are made from duralumin with a thickness of 1.5 mm, and the external fairing - from duralumin with a thickness of 0.8 mm. In the front part of the sprayer on the frame a shaped welded ring made from AM$_{TS}$AM material with a thickness of 1.5 mm is installed.

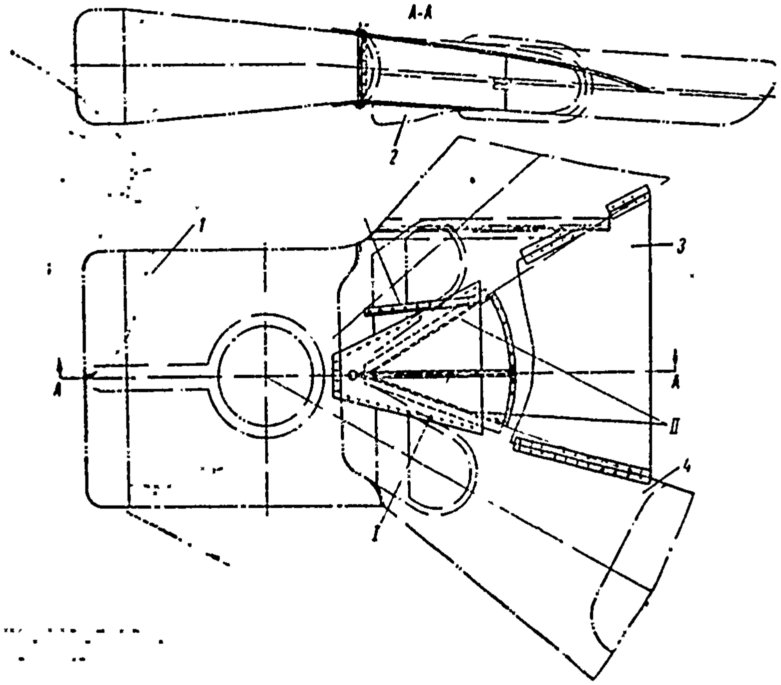

Fig. 192. Tunnel sprayer: 1 - air intake; 2 - additional air intake; 3 - reflector; 4 - dispersing channels; I - flaps open; II - flaps closed.

The central (third) tunnel is formed between the upper reflective plate and the lower platform made from D16A material with a thickness of 1 mm, and from the sides is limited by dissector walls made from the D16A material with a thickness of 1 mm edged on the leading edge by a sheet of stainless steel with a thickness of 0.5 mm. The central tunnel serves for decreasing the shaded space between the sleeves of the sprayer.

The sprayer has a flanged coupling on screws on the right sleeve. The coupling is made so that it is possible to transport the dismantled sprayer in the aircraft.

In the upper part of the sprayer there is an opening for installation of the metering vent and a concavity (knockout) under the front pneumatic cylinder of the metering vent. In the bottom part air intakes are installed for the additional blowing out of the sleeves, and also there are cutouts for increasing the width of wave and the more uniform distribution of chemicals over the surface to be treated. The tunnel sprayer is connected with the metering vent with the help of six bolts welded to the flange of the vent.

The tunnel sprayer is fastened to the bottom part of the fuselage with the help of eight rigid, regulated in length, steel tubular struts. The struts with reciprocal brackets on the fuselage are connected by self-locking rollers.

When the equipment is turned on the powder being poured out of the tank goes through the metering vent into the metering disk and into the diffuser of the sprayer and by the incoming flow of air is blown out through the three discharge channels. The sprayer has a scraper for cleaning the inner channels from stuck chemicals.

The pumping unit (Fig. 193) serves for the feeding of liquid under pressure to the underwing rods, for mixing the liquid chemicals of normal toxicity which are fed into the tank with the help of a hydraulic agitator, and also for the mixing of highly toxic chemicals with water and the feeding of liquid emulsion under pressure into the underwing rods.

The pumping unit:
8-blade air vane;
pulley with brake bank;
water pump from the AM-42 engine;
suction sleeve with flange;
release valve;
two pneumatic cylinders for control of valve and brake;
feedthrough cock;

measuring hopper;
check valve;
drain cock.

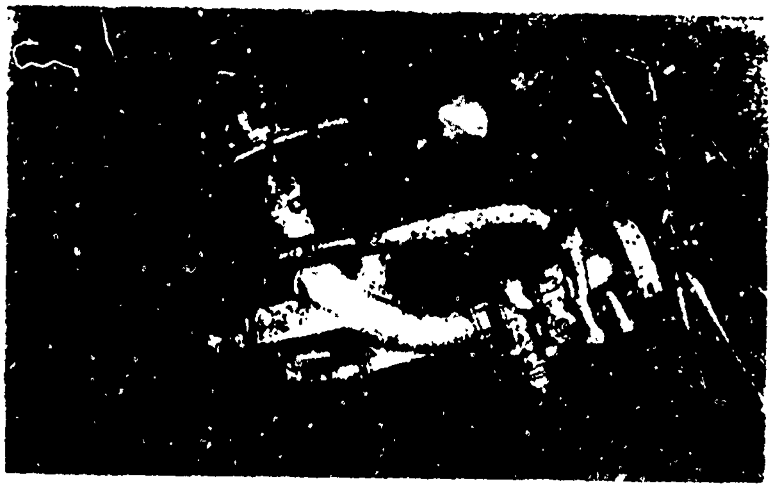

Fig. 193. Pumping unit with the separate supply of chemicals (issue 1961-1962): 1 - water pump from the AM-42 engines; 2 - suction sleeve; 3 - measuring hopper; 4 - chamber with alve for the supply of liquid into the underwing rods; 5 - flange; 6 - branch of the hydraulic agitator; 7 - pressure pipe; 8 - lubricator; 9 - air vane; 10 - brake of the air vane; 11 - drainage plug.

The 8-blade air vane consists of a set of four stamped Duralumin blades with a thickness of 3.5 mm and four stamped Cromansil plates with a thickness of 1.2 mm riveted together with a hub at an angle of 45° to one another.

The air vane is mounted on the conical part of the pump shaft on a key and is locked by a nut puller. When it is loosened the screw subtends from cone. The brake pulley is mounted on the pump shaft on a key and in fastened with a bolt. The construction of the braking device of the sprayer is analogous to the air vane.

The pump shaft is connected by a universal joint with the air vane, which under the action of the airflow and a freed brake band rotates the impeller of the pump. The entire transmission system with bearings is mounted in a steel container, into which with the help of an automatic lubricator the lubricant is supplied.

Welded to the container are the lifting eyes of the pumping unit, the brackets of the pneumatic cylinder, and the brackets of the shaft of the lever for tension of the brake band.

The suction sleeve has the form of a pipe of varying section welded from steel punched sheets with a thickness of 2.5 mm. In the upper part a flange is welded to the sleeve for attaching the pumping unit to the vent of the tank. On the side of the sleeve a bracket is welded for attaching the chamber with the valve which connects the pumping unit with the underwing rods.

Valve control is carried out with the help of a pneumatic cylinder (Fig. 194) which is installed on the welded bracket of the sleeve of the sprayer and has the possibility of free rocking in the pins of the bracket. The bracket of the rod of the pneumatic cylinder is connected directly with the valve rod and through a system of levers with feedthrough cock No. 630700 of the high toxicity system and the valve for input of liquid from the tank.

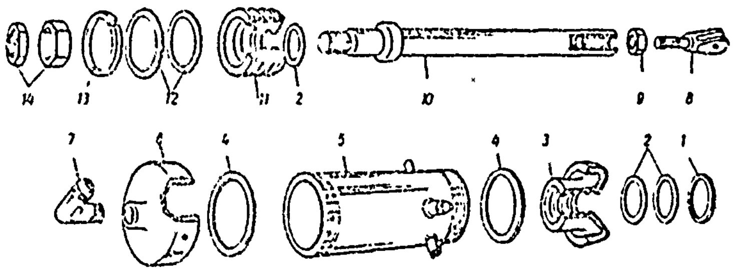

Fig. 194. The standard pneumatic cylinder for control of the valve and brake 1956-1962 issue: 1 - felt gasket; 2 - sealing ring; 3 - cover; 4 - sealing ring; 5 - cylinder; 6 - cover; 7 - elbow; 8 - yoke; 9 - nut; 10 - rod; 11 - piston; 12 - sealing rings; 13 - oil ring; 14 - nut.

In the bottom part of the suction sleeve there is a measuring hopper which serves for the control of the supply of highly toxic chemicals and ensuring the required emulsion concentration. The measuring hopper consists of a housing, a locking needle, a sleeve with a handwheel, and a nut with a connecting piece.

Regulation of the measuring hopper is done by rotation of a handwheel. During the rotation of the handwheel clockwise a decrease in the chemical concentration occurs or the access of chemicals into the pumping unit can be stopped completely. On the surface of the connecting piece of the nut there are transverse graduation marks, and on the surface of the sleeve with the handwheel there is one longitudinal graduation mark.

During the regulation of chemical concentration it is necessary that the graduation mark on the handwheel coincide with the appropriate transverse graduation mark on the connecting piece. Obtaining of the necessary emulsion concentration depends on the thickness of the chemical and temperature conditions during spraying, therefore metering is established experimentally.

The outlet pipes of the pump are attached to the chamber. From the forcing tube of the pumping unit the discharge is taken to the hydraulic agitator which brings the liquid inside the tank.

The hydraulic agitator is located inside the tank and is made from steel tube. Fastened to the tube with the help of clamps are the individual figures of the scale, which during calibration of the tank are established at a height in such a way that they show the quantity of liquid in the tank based on its level. The value of a division is 100 liters.

With a working pump and a closed valve the liquid being transferred by the pump circulates through the hydraulic agitator from the bottom part of the tank into the upper, by which is achieved the mixing of chemicals which are found in the liquid in an undissovled state, and thereby its constant concentration is maintained. With the valve open the access of liquid into the underwing rods is accomplished.

The underwing rods (see Fig. 186) serve for the spraying of liquid chemicals. The rods are sectional and are made from steel tube with a diameter of 44 mm of drop-shaped cross section with discharging sleeves welded onto them (the step of welding 180 mm) and arranged at an angle of 60° to the horizontal axis of the aircraft. The connecting tubes which connect the pumping unit with the underwing rods have elongated sleeves - three on the left and four on the right tube.

Into the sleeves of the rods detachable check valves are installed which cut off the wave of liquid when the valve of the pumping unit is closed. Outside to the sleeves of the rods jets are fastened with the help of locks of the phonograph type. Seventy-eight jets are installed on the rods. On subsequent series of aircraft 80 jets are installed. Six types of jets can be installed depending on the size of the outlet, thanks to which it is possible to obtain different per-second issue of suspension.

The rods are fastened by self-locking rollers to the external bearing brackets of the flaps of the lower wing over the entire span and exceed the overall dimensions of the wing by 70 mm on each side. The rods are connected to each other by durite hoses with the help of clamps and inner kegs. The end rods are screwed into the last wing rod and can be removed during flights. Into the open end of the last rod in this case plug are screwed in.

The per-second discharge of liquid (pure water) through jets at a flying speed of 160 km/hr is given in Table 20.

The rate of flow can be decreased by the arrangement of blind jets, 40 of which accompany the equipment.

Table 20

(1) № жиклера	(2) Размер окна жиклера, мм	(3) Количество жиклеров	(4) Расход жидкости, л/сек		(1) № жиклера	(2) Размер окна жиклера, мм	(3) Количество жиклеров	(4) Расход жидкости, л/сек	
			(5) без клапанов	(6) с клапанами				(5) без клапанов	(6) с клапанами
1	1×1	78	3,2	2,0	4	3×5	78	15,2	13,3
2	1×5	78	9,9	7,9	5	4×5	78	16,4	14,2
3	2×5	78	12,7	10,0	6	5×5	78	17,0	15,8

KEY (1) No. of jet; (2) Dimension of window of jet; (3) Number of jets: (4) Rate of flow *l*/s; (5) Without valves; (6) With valves.

The tank for highly toxic chemicals (Fig. 195) is welded from stainless steel with a thickness of 1.2 mm and has a capacity of 39 liters. It is mounted on a special pylon between frames No. 13 and 14 on the right side outside of the fuselage and it is secured with two tapes. The tank is provided with a filler neck with a pressurized cover, and indicator of chemical level (glass tube with a scale), a crosspiece for supplying the tubes for pressurization and drainage and the attachment of a safety valve.

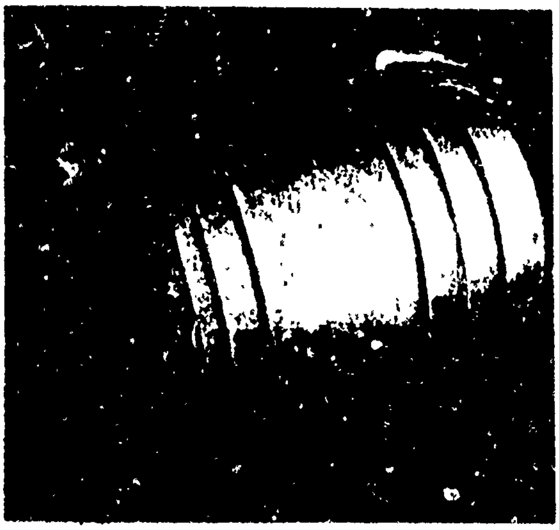

Fig. 195. Tank for highly toxic chemicals (1959-1962 issue): 1 - tank; 2 - fitting for attachment of external piping; 3 - glass tube with scale (level gauge of chemicals); 4 - crosspiece; 5 - filler neck.

The tank is connected with pumping units by an external conduit made from stainless steel.

Purpose and construction of the OZh-2 device. The OZh-2 for the valveless cutoff of liquid with the help of an ejector and control of its expenditure by the replacement of the nozzle of the ejector is intended for the instantaneous cessation of the outflow of liquid from the sprayer after the closing of the valve of the sprayer and pumping it from the rods into the ventral tanks with a capacity of 8 liters each for the purpose of protection of a series of sections of fields which do not require treatment.

The OZh-2 is installed on the An-2 aircraft in a set with the serial sprayer Sh7609-500 or the modified sprayer Sh7628-215.

The device is intended for working with chemicals which do not require the fine atomization of liquid, including herbicides and highly toxic chemicals.

With installation of the OZh-2 device on the aircraft the serial pumping unit and underwing rods are used without any modifications with the exception of the readjustment of underwing rods from the right wing to the left, and vice versa, and the installation of their fittings upward and forward in flight. From the fittings of serial rods it is necessary to remove all jets and instead of them to install the adapters of rods of the OZh-2 device. Instead of the serial ventral rods the ventral rods of the OZh-2 device, small tanks with the ejectors, and interconnecting tubes are installed.

For attachment of the OZh-2 device on aircraft the four bearing brackets of the tunnel sprayer and the sprayer of serial agricultural equipment without any modifications are used.

Inside the ventral rods removable ejector nozzles are installed which are made from plastic and by which the rate of flow is regulated. The ejector nozzles have various dimensions with diameters of the outlet of the nozzle of 6, 8, 12, and 16 mm, by which the metering of the expenditure of chemicals is achieved.

The ejector is connected with the rod, pump, and tank with the help of three union nuts. The airtightness of the connection is ensured by rubber packing rings. The suction tube of the ejector is connected with the ventral tank by a union nut. The small tanks are hung up by two struts each, and the third attachment point is the suction tube of the ejector.

On the tank there is a vent line, inside which the rod moves in two directions. Inside the small tank at one end of the rod a foam plastic float is fixed, and at the second end, outside, a valve is installed which in the initial position seals shut the vent line of the tank (or connects the inner cavity of tank at the necessary moment with the atmosphere after the liquid reached a definite level in the tanks).

The OZh-2 works automatically and special controls are not necessary.

The control loop of the sprayer does not undergo changes.

The operating principle of the OZh-2 is based on the formation of rarefaction in the tanks during the movement of a liquid jet through the nozzle of the ejector. The liquid, passing under pressure through the nozzle installed in every ventral rod, creates a rarefaction in the tanks of an order of 0.3-0.4 kgf/m^2 which is maintained as long as the movement of liquid from the nozzle continues.

Before the first flight of the aircraft air is found in the tanks. The float in this case is lowered down as far as it will go and the valve on top closes the vent line of the tank. With the switching on of the pump of the sprayer air is partially suctioned out of the tanks, the valve shuts the vent line tightly, and rarefaction is maintained in the tank. At the moment of closing of the release valve of the pumping unit the liquid which remained in the rods of the sprayer is instantly removed into the

the ventral tanks and in this case the outflow of liquid is ceased (cut off) instantly. In proportion to the entrance of liquid from the rods into the tanks the pressure inside the tanks rises, and when it becomes close to atmospheric the float rises and the valve of the tank is opened. The liquid remaining in the rods after cutting off is drained into the small tanks by gravity. With the switching on of the pumping unit of the sprayer the process of the creation of rarefaction in the tanks is repeated.

After landing the small tanks can contain liquid in a volume which corresponds to the volume of the rods.

The regulation of the rate of flow is carried out by the removable nozzles of the ejector. Every OZh-2 device has a complete set of ejector nozzles with various outlets with two nozzles of every dimension (one each for the right and left ejector).

Table 21 shows the rates of flow compiled on the results of a control test of the given device.

Table 21.

Diameter of the outlet of nozzle, mm.	6	8	12	16
Flow rate of water, l/s.	2.1	3.4	7.1	11.2

For instance, with a width of working swath of 30 m for operation with a standard of expenditure of 25 l/ha it is possible to install a nozzle with an output opening of 8 mm, and a standard of rate of flow of 50 l/ha will be provided for with the installation of a nozzle with a 12 mm opening.

During the operation of the OZh-2 device it is necessary to see to it that all the connections are sealed and air was not sucked into the small tanks, the ejectors, rods, and under the valves of the small tanks.

During operation with highly toxic chemicals it is necessary to observe all the requirements of instructions because in the small tanks after landing there is always a residue of liquid in a volume equal to the volume of the rods (approximately 8 *l*), and the valve of the small tank in this case is open.

§ 46. CONTROL OF AGRICULTURAL EQUIPMENT

Control of agricultural equipment is pneumatic and is accomplished by compressed air from an airborne pneumatic circuit through a PU-7 reducing valve (Fig. 196).

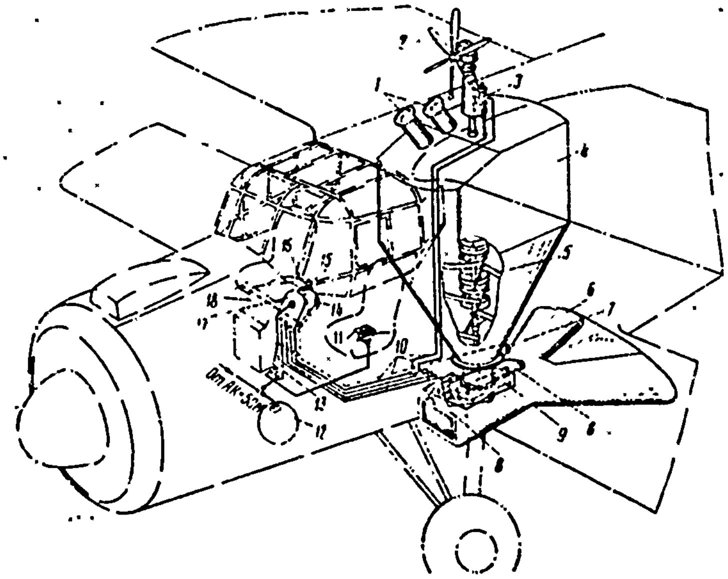

Fig. 196. The layout of the duster and its pneumatic control: 1 - loading pipes; 2 - air vane; 3 - pneumatic cylinder of the air vane brake; 4 - tank for chemicals; 5 - rippers; 6 - tunnel sprayer; 7 - plug-type connector; 8 - pneumatic cylinders of gates; 9 - metering vent; 10 - conduit for the pneumatic system; 11 - manometer; 12 - tank with compressed air; 13 - PU-7 reducing valve; 14 - tube for signalling of the opening of gates (red); 15 - knob for switching on of pneumatic stopcock; 16 - tube for signalling of the closing of gates (green); 17)- control panel for agricultural equipment; 18 - network protection automat.

The fundamental schematic of control of the agricultural equipment of duster and sprayer is shown in Fig. 197.

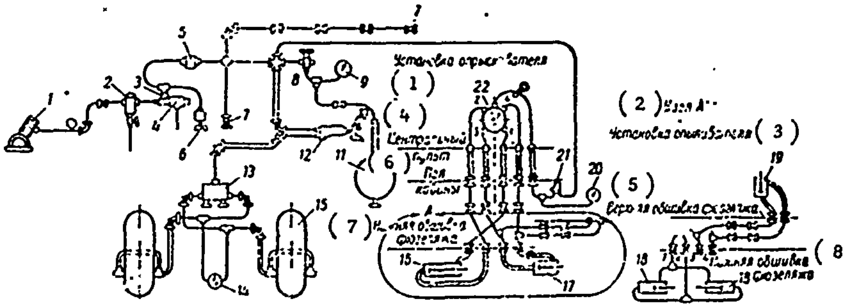

Fig. 197. The fundamental diagram of the pneumatic system of the An-2 aircraft: 1 - AK-50M compressor; 2 - FT-9900 filter-sump; 3 - check valve; 4 - automatic pressure control; 5 - direct-flow filter; 6 - loading pipe; 7 - recharging connection; 8 - cock with reducing valve; 9 - MV-80 manometer for 80 kgf/cm^2; 10 - control level for PU-7 reducing valve; 11 - tank with compressed air; 12 - PU-7 valve on left steering control; 13 - PU-8/1 differential; 14 - two-pointer manometer for 12 kgf/cm^2; 15 - landing gear wheel; 16 - cylinder for control of sprayer valve; 17 - cylinder for sprayer brake; 18 - cylinder for control of gates; 19 - cylinder for air vane brake; 20 - MV-60 manometer for 60 kgf/cm^2; 21 - PU-7 reducing valve on the floor of the cabin; 22 - cock for control of agricultural equipment.

KEY: (1) Duster installation; (2) Unit "A"; (3) Sprayer installation; (4) Central panel; (5) Upper fuselage covering; (6) Floor of cabin; (7) Lower fuselage covering; (8) Lower fuselage covering.

The pneumatic control includes the PU-7 reducing valve, pneumatic stopcock, a manometer which shows pressure in the main control line of agricultural equipment, pneumatic cylinders, and pipelines.

The PU-7 reducing valve is intended for the reduction (lowering) of atmospheric pressure which enters from the tank of the pneumatic system of the aircraft under a pressure of 40-50 kgf/cm^2 to a pressure of 10 kgf/cm^2 in the sprayer variant and 16 kgf/cm^2 in the duster variant. This is necessary to control the valve, the gates, and the braking device of the air vane of agricultural equipment.

The PU-7 valve is installed underneath on the floor of the cockpit under the central control panel. The adjusting screw is screwed into a special bracket attached on top on the floor of the cockpit, and it is locked with a lock nut. The PU-7 valve (Fig. 198) in its construction is analogus to the construction of the PU-7 valve, control of the brake wheels, and runners of the landing gear.

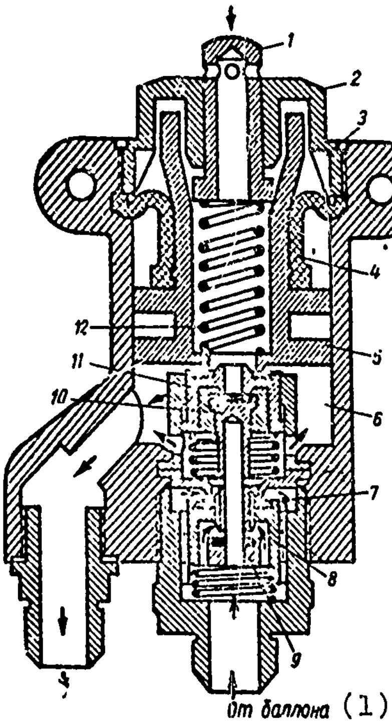

Fig. 198. PU-7 reducing valve: 1 - pusher; 2 - nut; 3 - ring; 4 - stocking membrane; 5 - piston; 6 - middle chamber; 7 - lower cavity; 8 - large inlet valve; 9 - small inlet valve; 10 - small outlet valve; 11 - large outlet valve; 12 - reducing spring.
KEY: (1) from tank.

With an adjusting screw the pressure in the PU-7 valve is established at 10 kgf/cm^2 for the sprayer and 16 kgf/cm^2 for the duster, and during the operation of agricultural equipment the atmospheric pressure is maintained constant.

With the KN-50 filling cock in the open position air from the tank will approach the PU-7 valve, is reduced to a pressure of 10 or 16 kgf/cm^2, depending on the type of equipment, and further will approach the distributing cock of the control equipment installed on the central control panel in the cockpit.

For checking the pressure in the pneumatic system for the agricultural equipment an MV-60 manometer for 60 kgf/cm^2 is installed on the left panel (instead of an oxygen manometer).

Pneumatic cock. Control of the operation of the duster or sprayer is accomplished by the same pneumatic cock installed on the central control panel in the cockpit. The cock is arranged so that control of it can be accomplished both by the aircraft commander from the left seat and by the copilot from the right seat. Such a placement of the cock in the cockpit considerably facilitates the handling of the aircraft when approaching the working section and on leaving it.

The pueumatic cock (Fig. 199) consists of a steel housing (made from 12KhNZA steel), a housing cover (D16T alloy), slide (bronze BRS-305), a shaft for control of the slide (steel 45), a steel plate with slots for fixation of the position of the handle and bracing of the cock to the panel, handle with rod-retainer, a catch, springs, washers, parts for packing, and other fasteners.

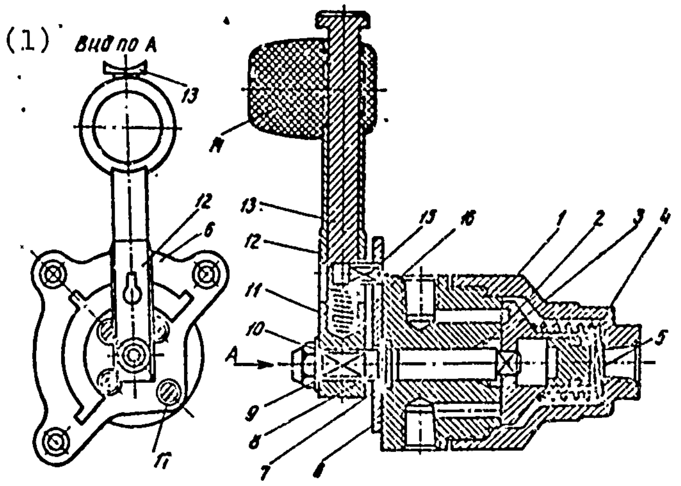

Fig. 199. The pneumatic cock for control of equipment: 1 - cover of cock; 2 - sealing ring; 3 - valve; 4 - plug; 5 - spring; 6 - plate; 7 - washer; 8 - shaft; 9 - washer; 10 - nut; 11 - spring; 12 - handle; 13 - rod; 14 - knob; 15 - catch; 16 - housing; 17 - screw.
KEY: (1) View through A.

The handle of the cock is fixed with the help of a stop entering into the grooves of the sector in four positions and in the following sequence: "Off," "Neutral," "Agitator," and "On."

During assembly the cavity of the valve is filled up with lubricant which consists of MS-24 oil or MK-22 oil and T-1 fuel in the volumetric ratio of 1:1. The operating surfaces of the washer and shaft are greased by TsIATIM-201 lubricant. During the screwing in of the thread it is greased with MGS TUMIP 351-53 lubricant. The cock is tested under a pressure of 30 kgf/cm^2 in all positions.

The pneumatic cock is installed in a special housing which is fastened in front of the central control panel of the cockpit.

Pipelines. Coming out on the lower fuselage covering are four through fittings (No. 1, 2, 3, and 4), to which the flexible RSD hoses of the pneumatic cylinders of the pumping unit and the pipelines of the pneumatic cylinders of the metering vent are joined. In the duster variant only two fittings are used (No. 1 and 2), the other two fittings (No. 3 and 4) are shut by plugs.

On the upper covering of the fuselage two fittings come out. The flexible hoses of the pneumatic cylinder of the column of the air vane (in the sprayer variant they are shut by plugs) are joined to them.

Use of the pneumatic cock. Fig. 200 shows the layout of the operation of the cock for control of agricultural equipment.

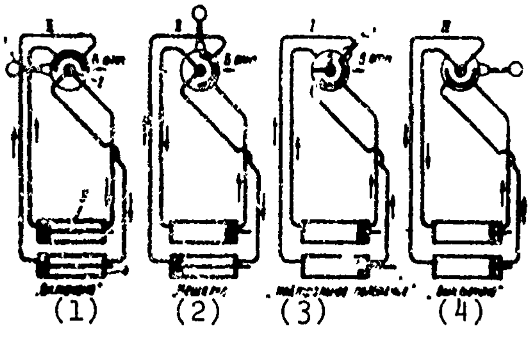
(1) (2) (3) (4)

Fig. 200. Principal of operation of the cock for the pneumatic control of agricultural equipment: 1 - handle of cock; 2 - supply of air; 3 - cylinder for control of the valve for the sprayer or the gates of the duster; 4 - cylinder for control of brake.
KEY: (1) "On"; (2) "Agitator"; (3) "Neutral: (4) "Off".
Designation: B ATM = to atm.

On the flight line the handle of the cock is set in the neutral position, in which the main pipeline is not found under pressure.

During starting of the engine, taxiing, and climbing the handle of cock should be in the "Off" position both in the duster variant and in the sprayer variant. After completion of takeoff the cock is set in the "Agitator" position in the sprayer variant and left in the "Off" position in the duster variant.

In the sprayer variant the turning of the handle of valve to the "Agitator" position turns on the pneumatic cylinder, freeing the brake, and in the "On" position operates the pneumatic cylinder for the valve opening (with the brake released).

The starting of liquid into the underwing rods while the motor is running is permitted only with the valve of the pumping unit in the closed position (the position of the handle "Off"). It is forbidden to turn on the sprayer from the "Agitator" position.

For the switching of sprayer from the operation of the hydraulic agitator to the opening of the valve for starting the liquid into the underwing rods it is necessary:

1) to turn off the sprayer (position of handle "Off");

2) pause for 3-6 s;

3) turn on the sprayer (position of handle "On").

Rotating of the air vane during the idling of pump for more than 20-30 s is forbidden.

In the duster variant during the rotation of the handle of the cock from the "Off" position to "On" (passing the intermediate position on the sector of the cock) the brake of the air vane is released and both pneumatic cylinders which open the gates operate simultaneously.

The opening of the gates of the metering vent is signaled with the help of SLTs-51 tubes mounted on both sides of the panel of the pneumatic cock. With both gates open the red warning lamp goes on and with closed gates - green. The switch is located in the bottom part of the same panel.

The regulating equipment for the high toxicity system. The equipment (Fig. 201) is mounted inside the aircraft on the right side of the cargo compartment and it consists of a PU-7 reducing valve, the reduction gear of low pressure 436, and the cock of low pressure 623600. The basic arrangement of the pneumatic system is shown in Fig. 202.

Fig. 201. Regulating equipment of the high toxicity system: 1 - PU-7 valve; 2 - reduction gear 436; 3 - pipeline; 4 - cock of low pressure 623600.

The PU-7 valve, which is powered from the pneumatic system of the aircraft, reduces pressure in the system to 5-7 atm and in its construction is the same as the PU-7 valves for the brakes and control of the agricultural equipment of the aircraft.

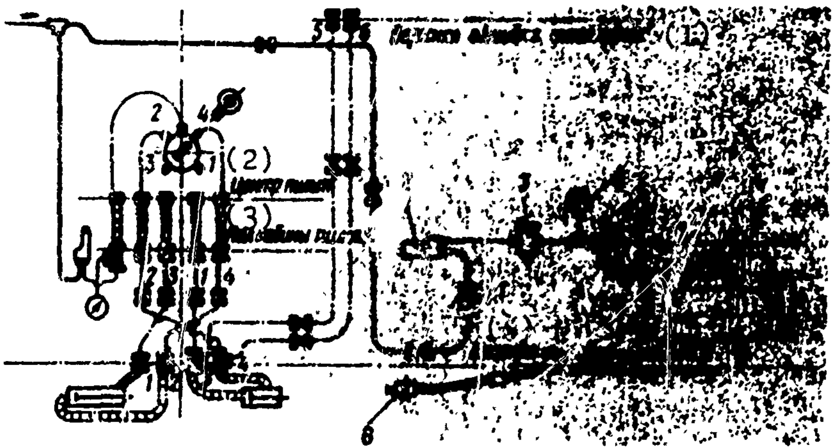

Fig. 202. The basic layout of the pneumatic system of the An-2 aircraft in an agricultural variant with a tank for chemicals: 1 - check valve; 2 - reducing valve PU-7 (UP 25/2); 3 - air reduction gear 436; 4 - pressure and vacuum gauge MV-16; 5 - cock of low pressure 623600; 6 - safety valve 634300; 7 - tank for concentrated products; 8 - measuring hopper.
KEY: (1) Upper covering of fuselage; (2) Central panel; (3) Floor of cockpit; (4) Lower fuselage covering.

Reduction gear 436, connected in series with valve PU-7, reduces the atmospheric pressure down to the operating boost pressure of 0.2-0.3 atm, and the cock of low pressure 623600 serves for the feeding of boost pressure into the tank and its drainage. On the shank of the shaft of the cock from within fuselage a pointer has been fastened which turns simultaneously with the handle of the cock which is located outside. The position of the pointer shows if the tank is connected with pressurization or drainage.

When spraying chemicals of high toxicity by turning the handle of the pneumatic cock into the "Agitator" position the pneumatic cylinder for opening the valve operates, and in the "On" position releases the brakes of the air vane of the sprayer.

Pressure in the system of pneumatic control during the separate supply of water and poison should be 16 kgf/cm^2.

§ 47. CARE OF AGRICULTURAL EQUIPMENT AND ITS MAINTENANCE DURING OPERATION

It is necessary to care for agricultural equipment and to service it during operation in strict correspondence with "Operating instructions for agricultural equipment on the An-2 aircraft" and the "Regulations for the maintenance of the An-2 aircraft."

Care of the Duster

During every postflight and periodic maintenance after 100 and 300 hours of flight it is necessary to:

1. Clean the tank and tunnel sprayer from the residue of chemicals. Clean and eliminate wash the contaminated parts of the aircraft of chemicals.

Note. The operation of cleaning and washing the aircraft and agricultural equipment from chemicals is carried out at the loading base of the temporary airfield prior to taxiing to the mooring ground.

2. Inspect the tank for chemicals, be convinced of the reliability of its attachment (specific attention is focused on the attachment of the tank to frame No. 8).

3. By switching the handle of the pneumatic cock verify the opening and closing of the gates of the metering vent during the simultaneous operation of braking devices.

4. Verify on the manometer the pressure in the system of pneumatic control of the duster (pressure should be 16 kgf/cm^2) and the signalling of the opening of the gates of the proportioning vent.

5. Check the pneumatic cock for airtightness under a pressure of 16 kgf/cm^2. In the case of a non-hermetic state disassemble and throughly rub the housing and valve. During assembly the cavity of the valve is filled with MS-20 oil.

6. Examine the tunnel sprayer, the metering disk, and the bearing bracket. Be convinced of the absence of damages as well as the reliability of attachment. Check the longitudinal clearance of the shaft of the mixer (it should not be more than 2 mm).

7. Through the inspection window be convinced of the presence and good condition of the rippers.

8. Examine the fastening of the column of the air vane. Be convinced of the absence of inadmissible wear of the brake band (a band having a thickness of asbestos gasket less than 3 mm, and also a burnt band are forbidden). Verify the presence of lubricant in the housing of the reduction gear.

9. Check the fastening and good condition of pneumatic cylinders. Be convinced of the airtightness of the connection of the pipelines of pneumatic control of the duster and the absence of damage to the rubber gaskets under the caps of the sprayer.

10. Grease the piston rods of the pneumatic cylinders for control of equipment with TsIATIM-201 lubricant.

11. Fill the housing of the reduction gear of the worm drive with lubricant. Grease the reduction gear with globoid meshing with oil 52 (VAPOR) after every 8 hours of flight.

12. Check the attachment, closing density, and condition of locks and glasses on the covers of cargo hatches.

During periodic maintenance after every 100 hours of flight of the aircraft it is necessary to:

1. Disassemble the pneumatic cylinders for control of agricultural equipment, clean them of lubricant and soilings, and check the state of rubber packing rings. If necessary replace them. Replace the lubricant and assemble the cylinders. Check the operation and the airtightness of the pneumatic cylinders.

2. Remove the cover of the reduction gear and remove lubricant and soilings, check the condition of the worm and gear and fill with fresh lubricant. Set the cover in place. Remove and disassemble the metering vent, cleanse thoroughly, examine, and if necessary replace the felt padding or rubber buffer.

Care of the Sprayer

During every postflight and periodic maintenance aft r 100 and 300 hours of flight it is necessary to:

1. Wash the tank, pumping unit, and pipelines by passing 200-300 liters of water through them with the pump working. Drain the residue of liquid from the pump through the drainage plug. Clean and wash the filter from the main line for loading of liquid chemicals.

2. Clean and eliminate wash from chemicals the contaminated parts of the aircraft and agricultural equipment.

Note. The operations of cleaning and washing the aircraft and agricultural equipment from chemicals are done at the loading base of the temporary airfield prior to taxiing to the mooring ground.

3. Examine the tank for the chemicals, be convinced of the reliability of its attachment (specific attention is turned to the attachment of the tank to frame No. 8).

4. By switching the handle of the cock of the pneumatic control verify the opening and closing of the sprayer valve.

5. Check the installation and fastening of the mirror, the cleanliness of the glass of the eyepiece, the cleanliness and condition of the covers for the sealing of the loading sleeves, and the attachment of the loading tube.

6. With the sprayer installed on the aircraft it is necessary to:

a) examine the liquid sprayer over the whole span of the pipeline (the rods), be convinced of the cleanliness of the openings of sprayers and reliability of their attachment on the fittings of the pipelines;

b) check if there are any breaks in the attachment of the pipelines (rods);

c) be convinced of the reliability of attachment of the tank for highly toxic chemicals, is the glass tube for the level gauge of chemicals intact; open the cover of filler neck and check the condition of the rubber gasket;

d) examine the air vane, be convinced that there are no damages to the blades or wobbling of the shaft of the pump at the bearings;

e) check the condition of the brake band and be convinced of the absence of oil on the pulley, and also check for inadmissible wear of the brake bank. Be convinced that in the "Agitator" position of the handle of the cock for control of the agricultural equipment the band does not touch the pulley, and in the "Off" position it reliably brakes the air vane;

f) check the attachment and condition of pneumatic cylinders, be convinced of the airtightness of the connections of the pipelines for pneumatic control of the sprayer and the absence of damages to the rubbers of cut-off values;

g) check on the manometer of pressure in the system of pneumatic control of the sprayer (pressure should be 10 kgf/cm^2);

h) in the case of the installation of the sprayer with the separate supply of water and chemicals to the pump of the sprayer the pressure in the system of pneumatic control of the sprayer should be 16 kgf/cm^2, and the pressure in the manometer of the pneumatic system of the extension tank - 0.2-0.3 kgf/cm^2.

During periodic maintenance after every 100 hours of flight of the aircraft it is necessary to:

1. Dismantle the pneumatic cylinders and perform the operations analogous to the inspection of pneumatic cylinders of the dusting equipment.

2. Remove lubrication and contamination and wash the cavity of the container for the roller for driving the impeller of the pump. Check the condition of bearings, the universal joint, and the presence of a clearance between the impeller and the pump housing (clearance should be from 0.7 to 1.5 mm). Fill with fresh lubricant.

CHAPTER IX

STORAGE AND CARE OF THE AIRCRAFT

§ 48. TYING DOWN THE AIRCRAFT

There exist two types of aircraft storage: in hangars and under the open sky. AN-2 aircraft are allowed for prolonged storage both under the open sky and in hangars, under the condition of the provision of correct care of them according to instructions for aircraft storage.

As a rule, at airports, flying schools and on operational airfields of special-purpose aviation the aircraft should be stored on equipped tie-down areas, called parking areas.

The aircraft parking areas are equipped with:

tie-downs concreted or embedded into the ground for mooring the aircraft;

moorings for attaching the aircraft to tie-downs;

chocks, installed under the wheels of the aircraft;

clamps for bracing ailerons, flaps, slats and aircraft control surfaces;

fire-fighting facilities;

benches;

jacks for lifting the aircraft;

ladders for the work of technical personnel on the aircraft during its maintenance.

The aircraft parking areas should be located on the dry, as much as possible, elevated part of the airfield, all unevennesses should be smoothed out, and for water – a drain made. Under the wheels it is necessary to place planks from 1.0 × 0.75 m boards, which should be impregnated with creosote. If the parking area is concreted, then the aircraft is placed without planks.

With placement of the aircraft on the tie-down area (Fig. 203) it is mandatory to consider the direction of the prevailing winds in the given locality. The An-2 aircraft should be placed with the engine against the wind, since with positioning in the opposite direction with a strong wind the load increases on flaps, ailerons, tail surface controls and other separate structural elements of the aircraft.

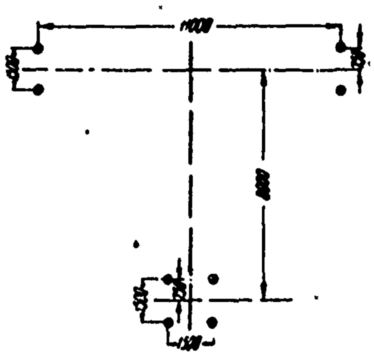

Fig. 203. The laying out of tie-down area for An-2 aircraft.

In the parking area equipment of the An-2 aircraft special attention must be given to the state of the tie-down fittings which should provide safe restraining of the aircraft during strong winds which exceed velocity 30 m/s. Anchors for securing the An-2 aircraft (Fig. 204) are made from rod steel with diameter 18 mm and length 1.2 m, on the ends of which loops are bent and connected by welding. The loops should be welded not end-to-end, but overlapping. Into the bottom large loop are inserted steel channel or flange beams with width of flange 80-100 mm, length not less than 1.2 m, which are placed in a pit under unloosened soil. When there are no metal beams, it is recommended to insert wooden logs 180-200 mm in diameter and 1.2-1.5 m long in the bottom large loop. It is recommended to make anchors from logs at operational points or temporary airfields for storing the aircraft not more than 1 year.

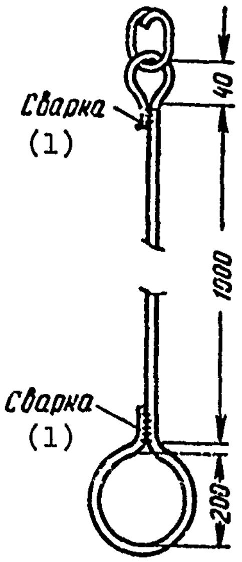

Fig. 204. Anchor for securing the aircraft.

KEY: (1) Welding.

On the tie-down area four anchors are sealed into the ground for securing by eyelets of the lower wing with double tie-downs (Fig. 205a) and four anchors for securing the aft end of aircraft by eyelets on fuselage frame No. 25 (Fig. 205b).

During storm winds of high force it is necessary to additionally restrain An-2 aircraft with tie-downs at four points on the landing gear (two points each on both sides). Such securing of aircraft on the tie-down area fully guarantees its safe storage with wind exceeding velocity 30 m/s.

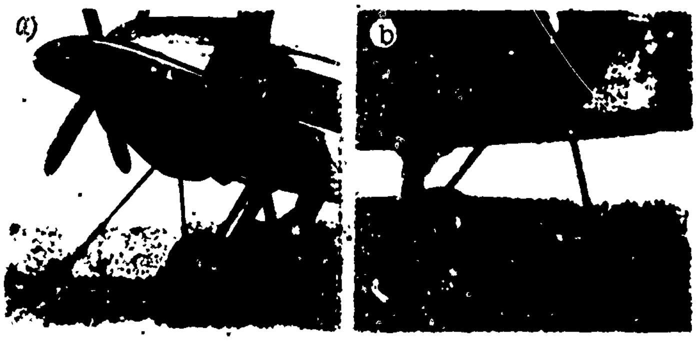

Fig. 205. Tie-downs for securing the aircraft on the tie-down area.

Every set of tie-downs consists of two double underwing, made from rod steel 10 mm in diameter, with length 1000 mm, one end of which is permanently attached to a triangle made of steel bar 18 mm in diameter (Fig. 206) having a hook for engagement of the eyelet of the lower plane, the other bottom end has a special catch for engagement with steel cable not less than 10 mm in diameter and with length about 1000 mm or chain.

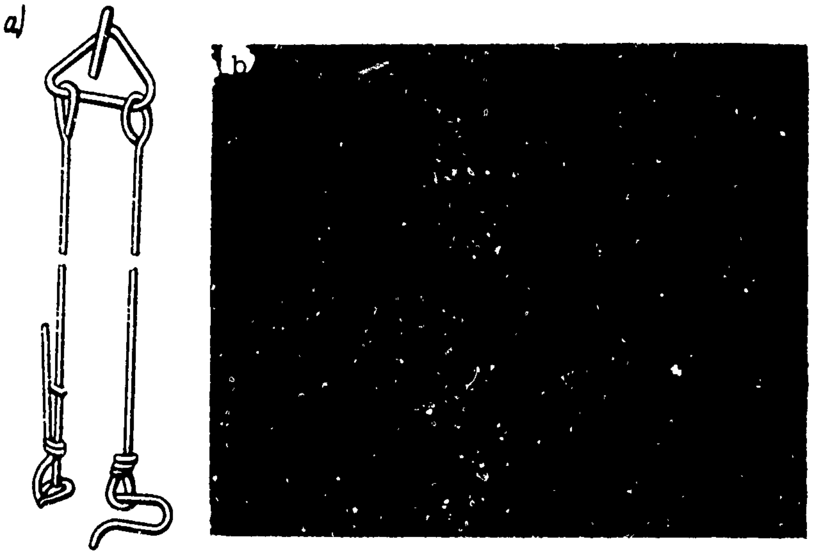

Fig. 206. Securing the aircraft on the tie-down area: a) Set of tie-downs; b) Tie-down angle bar.

It is recommended for securing aircraft to use chain with the same length as cable with thickness of links not less than 10 mm. When securing aircraft with the aid of chain it is necessary to pay special attention to the state of the chain links, to check whether there are any cracks of breaks of links. With such tie-downs the tail section of the aircraft fuselage is tied down with length of the tie-downs within 600-700 mm.

It is also possible to secure aircraft on the tie-down area with the aid of plant tie-downs, but these tie-downs do not possess sufficient strength and under wind force above 30 m/s there is observed shearing of the steel pin of the catch for attaching the cable to the rod of the tie-down, which is designed for load 1450 kg (the load on the tie-down with wind velocity 30 m/s is 1400 kg; at 35 m/s - 2300 kg and at 40 m/s - 3600 kg). A break of 8 mm cable of the plant tie-down occurs at force 4900 kg. Therefore, it is necessary to supplement plant tie-downs with a second tie-down and to secure the aircraft to anchors additionally with the aid of a link or eye, installed in the opening of the upper part of the tie-down rod.

Note. Tie-downs should not be highly stretched when securing aircraft to anchors to avoid deformation of wing half-cells with settling of one of the shock struts of the landing gear at rest.

With hangarless storage of the aircraft it is necessary to:

1. Install chocks under the landing gear wheels on both sides; position the tail wheel in the direction of flight of the aircraft.

2. Install clamps on the rudder and elevator (cable braces), external clamps - on upper flaps and ailerons between the fillet of the upper wing and flaps and between the flaps and ailerons. It is recommended to install the external clamps on slats at ribs No. 16.

3. Thoroughly cover the power plant, the cockpit canopy, landing gear wheels and pitot-static tube; close all hatches and the entrance door to the fuselage compartment.

With prolonged storage of aircraft during the winter period under the wheels and tail wheel, skis and tail skid it is necessary to install wooden planks to avoid the freezing of wheels and skis.

For combating icing of the upper wing it is recommended to place easily removable covers on it made of cotton fabric.

During delivery of the aircraft prior to protection, at operational points, the access hatches, filler necks of fuel and oil tanks and the entrance door to the fuselage compartment should be sealed.

§ 49. MEASURES FOR PROTECTION OF AIRCRAFT COMPONENTS AND PARTS FROM CORROSION

During the operation of An-2 aircraft one should pay special attention to protection of the aircraft from corrosion, especially when performing chemical aviation operations.

Moisture is the main cause of corrosion of aircraft parts. The places of aircraft parts, affected by corrosion, themselves possess hygroscopicity and soak moisture even from the air. The cause of corrosion is also the direct contact of duralumin with salt, sulfur or chemicals. Therefore, during operation it is categorically forbidden to transport salt, sulfur, salted fish in open form on the An-2 aircraft, and it is also necessary to take all measures to see that toxic chemicals do not penetrate inside the aircraft during the performance of chemical operations.

An external sign of the beginning of corrosion is tarnishing of the surface and the formation of miniature spots, and subsequently pits, which gradually increase and penetrate into the depth of the metal. As a result of this the thin sheets of the aircraft structure, the skin and the spar webs can be destroyed in a very short period with the formation of through holes, and separate load-bearing elements of the airframe structure (transverse and longitudinal assembly) as a result of their weakening will begin to fail under the action of the load.

During the destruction of light aluminum alloys three forms of corrosion are usually observed:

1) surface corrosion is formed in the form of a light film on separate, but adjacent to each other, grayish-white spots, not having a surface damaged by pits, but points of slightly rough;

2) spot corrosion appears in the form of pits, isolated from one another, sometimes having the form of spot black pin holes;

3) intercrystalline corrosion, going along grain boundaries (crystals) of metal, where corrosion destroys the bonding of crystals and thereby weakens the metal. This form of corrosion is most dangerous, since the metal sharply reduces its strength and it is difficult to detect the beginning of its failure. Besides aluminum alloys, high alloy steels are subject to this form of corrosion. Intercrystalline corrosion is usually checked by study of a section, taken from the external surface of the corroded part, under a microscope.

For protection from corrosion the aircraft parts have a protective coating. Duralumin parts are anodized, primed and are covered with airplane dopes, steel parts - are zinc-plated or cadmium-plated. The whole external surface of the aircraft is painted.

Protection of the aircraft parts from corrosion is basically reduced to the thorough preservation of the protective coatings of the aircraft. The anode coating on the duralumin surface, the protective coating of steel parts and paint coatings by all measures should be protected from scratches, nicks and other damages, at which the base metal is bared, which leads to the appearance of areas of corrosion. In connection with this at every postflight and 100-hour periodic maintenance of the aircraft it is necessary to thoroughly remove dust and dirt, which retain moisture for a long time and thereby, by destroying the paint coatings, facilitate the appearance of corrosion in the aircraft structure.

In summer remove grease spots and dirt from the surface of the aircraft with warm soapy water, after which wipe these places dry with clean cotton fabric. Do not allow the accumulation of dirt on the fuselage covering, under the cockpit floor, the cargo compartment and in the tail section of the fuselage, for which after every 100 h of flight remove the panels of the cargo compartment floor as well as in the tail section and thoroughly remove the dirt from the structural elements of the aircraft fuselage.

Note. On aircraft of the agricultural version remove the panels of the cabin floor and the tail section during every postflight maintenance.

In winter use kerosene for washing the grease spots and dirt. Wash the places on the skin of the right side of fuselage, smoke-blackened by exhaust gases, with kerosene, and then soapy water.

For preservation of the paint coating from damage it is necessary to observe the following precautionary measures:

1. Do not lay a tool, spare parts, oiled and gasoline impregnated rags on the surface of wings and the fuselage.

2. When working on the aircraft it is mandatory to use protective mats, rugs and carpets made of rubber or tarpaulin, which

are placed on the wing center section in treadways of technical personnel as well as on the wings.

3. Avoid impacts against the metal and fabric covering.

4. Do not spill gasoline and oil on the surface of the aircraft, but with accidental spilling immediately wipe it dry.

5. Do not spill electrolyte from the battery, because it causes corrosion, as a result of which the metal will be completely destroyed.

6. During execution of chemical aviation operations thoroughly paste over all hatches of the tail section of the fuselage and the junctions of upper wing fillets with the fuselage to avoid the penetration of toxic chemicals inside the aircraft. With the contamination of the surface or inside the aircraft by toxic chemicals these places must be thoroughly washed with water.

7. Under transport conditions it is forbidden to transport salt, sulfur and salted fish on the aircraft in unpacked form.

8. It is recommended to remove dust from the inner cavities of the aircraft by compressed air at pressure not higher than 1 kgf/cm^2.

With damage of paint of the aircraft parts under summer conditions it should be renewed, and in winter grease the exposed places on metal aircraft components with a UN (commercial vaseline) lubricant film, having preheated it to 20-25°C, and apply with a bristle brush. With the first possibility this coating should be removed and painted.

After a rain in no case leave wet covers on the aircraft. Remove wet covers from the aircraft and dry. After a rain open all hatches and doors of the aircraft and leave the aircraft in such a position for several hours for ventilation.

§ 50. CARE OF THE METAL COVERING OF THE AIRCRAFT

Flaw Detection of the Metal Covering

During inspection of the aircraft on the fuselage covering and the wing center section there are allowed:

1) smooth dents with depth up to 2% of the greatest width of the dent and area not more than 50 cm^2, and on the metal covering of the wings, stabilizer and fin – smooth dents with depth up to 1.5% of the length of the dent, if they are not caused by loss of stability of the adjacent structural elements. In this case check that the adjacent structural elements are not destroyed and do not have shearing of rivets. On each side of the fuselage without straightening there is allowed not more than 10 smooth dents of limiting size;

2) single nicks without cracks and scratches with depth not more than 20% of the thickness of the sheet, but not more than 0.2 mm. Dents, formed on the fuselage covering, larger than the permissible dimensions must be straightened. If after straightening the dents banging appeared in the straightened sections of skin or sections adjacent to it, then to the inside of the skin are riveted supporting sections. With the appearance of cracks D16AT duralumin patches, with thickness equal to the thickness of skin, are riveted to the skin.

When in the fuselage covering, on the section between two adjacent frames and stringers, there exists not more than one crack with length not more than 15 mm, drill the edges of the crack with a drill 2-3 mm in diameter and rivet the D16AT duralumin patch from within the fuselage

To the places of the fuselage covering, having scratches with depth more than 20% of the thickness of the sheet or more than 0.2 mm and holes, not protruding in size beyond the section between two adjacent frames and stringers, rivet patches made of D16AT duralumin.

Holes in the covering of slats, flaps, ailerons and controls not more than 25 mm in diameter are glued with patches made of AST-100 aircraft fabric.

Replace sheared or weakened rivets.

When defects exist, exceeding the foregoing limits, send the damaged structural elements to repair enterprises for repair:

1) fuselage – when in the skin there exist holes exceeding in size the limits of the section between two adjacent frames and stringers;

2) wing center section – when in the skin there exist dents larger than permissible dimensions, scratches with depth more than 20% of the thickness of sheet or more than 0.2 mm and holes;

3) the detachable parts of wings, stabilizer and fin -- when in the covering there exist dents larger than the permissible dimensions and holes;

4) slats, flaps, ailerons and controls – when in the skin there exist holes with diameter more than 25 mm and dents.

Repair of Fuselage Covering

The installation of patches. Cut out the damaged section in a vertical direction to the edge of the stringers, and in horizontal – to the boundaries, 15 mm from the web of the frame. Round off the angles of the cutout with radius 20 mm. Rivet the patch along the stringers with a single-row rivet seam with 20 mm spacing, and along vertical line — with double-row seam with the same spacing.

Drill the holes in the patch under the rivets in stringers and frames through the old holes. If the old holes became oval, the diameter of the rivet must be taken one number larger, but the same type.

Along the whole perimeter of the patch remove the bevel at a 45° angle, round the angles of the patch with radius 5 mm.

Make the patch from tempered D16AT material with thickness equal to that of the covering being repaired. When there is no D16AT sheet the patch can be made from tempered D17 sheet, but the thickness must be increased by 15-20%.

During repair it is permitted to use rivets made of D18 material which can be riveted any time after hardening (but not earlier than four days).

When a small crack exists in the skin, but not more than one in the section, drill the edges of the crack with a drill 2-3 mm in diameter and apply the patch from inside the fuselage.

The installation of patches is allowed only under field conditions. At repair bases it is mandatory to remove the patch and repair with partial or complete replacement of the sheet of skin.

With damage to the skin, exceeding in size the limits of two adjacent stringers or frames, it is necessary to replace part of the sheet or the entire sheet. During replacement of part of the sheet the latter is attached on the frames or stringers. Install the new sheet in such a way that its front edge in the direction of flight and the top lateral side would pass under the sheets of the remaining skin. In this case it is not allowed that the joints fall into one vertical section with the adjacent sheets. The thickness and material of the newly installed sheets of the skin should be identical to that being replaced.

Use rivets of the same type and material: there is allowed an increase in the diameter of the rivet by one number larger.

During repair of the fuselage covering it is necessary to follow the recommendations and instructions of the manufacturer.

§ 51. CARE OF THE FABRIC COVERING OF THE AIRCRAFT

Care of the Paint Coating

During operation of the aircraft the fabric covering of wings, tail surfaces, flaps, ailerons and controls perceives large loads from aerodynamic forces, in normal horizontal aircraft flight with gross weight G = 5250 kg comprising more than 70 kg/m^2 of the wing area, and with operational overloadings considerably greater pressure. In connection with this the monitoring and care of the state of the fabric covering should always be increased both on the part of technical personnel and the crew.

It is necessary to remember that flight on the aircraft even with an insignificant rupture of the fabric covering is forbidden.

Care of the fabric covering of the aircraft is primarily reduced to care of its paint coating. Correct care of the paint coating – one of the conditions of preservation of the strength and aerodynamic characteristics of the aircraft. Technical personnel are obligated at the proper time to eliminate discrepancies and to take all measures for preservation of paint coatings, remembering that with correct care the serviceable life of the paint coatings of the aircraft can be considerably increased.

For protection of the paint coatings of the aircraft from destruction it is necessary to:

1. Tightly close with covers all hatches and doors, thoroughly cover the propeller, power plant, cockpit canopy and pitot-static tube to prevent the dust and atmospheric deposits from getting into the aircraft.

2. At the proper time remove dust and moisture from the external surface of the aircraft by a soft cotton cloth.

3. Clear drain holes.

4. In the warm season in dry weather open all hatches for ventilation of the aircraft, having preliminarily removed the covers.

5. At the proper time remove snow from the external surface of the aircraft by soft hair brushes or soft cotton cloth, without allowing damage to the paint film with this.

6. Not allow harmfully acting liquids (petroleum products, acids, alkalis, etc.) to get on the paint coating. During operation of the aircraft it is forbidden to:

a) lay out wet covers on the wings of the aircraft for drying;

b) wash the skin with gasoline, kerosene, acetone, acids, alkali and other such liquids;

c) spill fuel and oil when servicing the aircraft;

d) walk on the aircraft in footwear not cleaned of dirt or snow.

It is also forbidden to remove dirt and grease spots with metal brushes and scrapers by means of scraping and chopping, by impacts with the shock absorber and by sprinkling with hot water.

After flights it is necessary to remove the accumulated dust, dirt and grease spots with a dry, clean cotton cloth (napkins). In the warm season the skin is additionally washed with clean napkins, first moistened with a warm soapy solution (300-400 g of grained soap per 10 l of warm water), and then with clean water. After washing wipe the skin dry.

It is forbidden to rub the surface of the aircraft skin with gasoline, because as a result of its intensive evaporation and cooling of the surface of the skin in the film of the protective paint coating cracks are formed, through which solar rays subsequently penetrate, destroying the film of the first coat, and subsequently moisture penetrates inside on the unprotected fabric skin and causes its rotting. At the first signs of rotting of the fabric covering it must be replaced.

During operation of the An-2 aircraft it is necessary to watch the tension of fabric and its attachment to the framework of wings and tail surfaces. The tension of the fabric is checked with a TP tensometer, and in the case of its absence - with the aid of a load weighing 1 kg, placed on the middle of the section between ribs, in this case the sag of fabric from its initial position should not exceed 5-8 mm.

Flaw Detection of Fabric Covering

Between two adjacent ribs of the wing, stabilizer, fin, flaps, ailerons and controls there is allowed the presence in the skin of not more than one hole with area up to 25 cm^2 or cut with length up to 200 mm, which are removed by the following means:

1) holes with area not more than 1 cm^2 and cuts with length not more than 20 mm are glued up with patches of aircraft fabric AST-100, ALVK, AM-100, AM-93;

2) holes with area more than 1 cm^2, but not more than 25 cm^2, and cuts with length over 20 mm, but not more than 200 mm, are sewn and glued with fabric patches.

When there are holes and cuts in the skin larger than the permissible dimensions and quantity, the detachable parts of the wings, stabilizer, fin, flaps, ailerons and controls must be sent to the repair base.

Repair of Fabric Covering

All types of fabric repair require the preliminary preparation of the fabric surface for repair. The fabric skin before repair should be washed, wiped with rags and dried. The torn edges of holes and protruding filaments of the fabric are evened with scissors so that the edges of the holes are parallel to the base and cleat of the fabric.

At a distance of 40-50 mm from the edge of the hole the paint coating is removed. The paint coatings are removed with RDV solvent by brushes, whereupon the dissolved paint film is removed by a wooden spatula or by the application of emulsion, which consists of 100 parts of AlN (cellulose dope) airplane dope and 10 parts water. After removal of the coating dry the fabric for 1 h and clean with glass paper.

Holes with area up to 1 cm^2 and cuts with length up to 25 mm after preparation, conducted as shown above, are glued on top with patches. The patch should overlap the edges of the damage by 40-50 mm. The edges of the patch are made with serrations for the best adhesion.

Holes with area over 1 cm^2 are repaired by sewing in patches and by gluing over the patch of the fabric cover with overlap of the seam by 40-50 mm.

Edges and holes are tucked inside, the patch is sewn in by "herringbone" seam with No. 10 threads, preliminarily waxed with beeswax. The patch before installation is covered with four layers of A1N airplane dope.

Cuts in the skin are sewn in by the "herringbone" seam and glued with a patch.

In the case of damage of the section between the ribs replacement of the section of fabric is possible. The damaged section is accurately cut out and sewn with a patch, as shown above. Over the section being repaired there is placed a section of fabric with width equal to that of the damaged section with 40 mm allowance per side. The section is fastened to two adjacent ribs, allowing its edges to approach under the 2NF sections on the ribs and their sealing with 3NF strips.

If the damaged section is located at the cantilever or root of the wing, then it is necessary to replace the section of fabric both on the damaged section and on the section adjacent to it, for which:

1) remove the surface strips along the ribs adjacent to the defective width of the skin and along the trailing edge between these ribs;

2) remove the 3NF strips;

3) remove the paint coating on the damaged place and cut off the damaged skin;

4) prime the metal covering with 138A primer;

5) apply a layer of AK-20 glue to the metal covering;

6) sew the new width with "herringbone" seam to the old damaged skin;

7) stretch and fasten the width on the leading edge or along the trailing edge;

8) stick the width to the frontal metal covering;

9) dope and paint according to the below-stated technological process of covering of units with fabric and their painting.

During sewing it is necessary to wet the old skin with an RDV solution, in order to avoid cutting its thread in two.

Strip the fabric covering for repair of the metal framework of the wing or tail surfaces in the following sequence:

1) wash the entire section of skin, which will be bent back, with solvent or A1N airplane dope; take out the 3NF strips;

2) undo the seam along the trailing edge;

3) after finishing the repair again soak the bent back fabric with RDV solvent and stretch to the old place;

4) place the 3NF strips into the 2NF sections, sew the fabric along the edge and glue the seam with serrated tape;

Note: 1. Take measures for preventing the flow of solvent or the removed layer of coating inside the unit.

2. It is not permitted to again place the removed skin on the frame.

3. At the moment of attachment of fabric when rolling the

3 NF plate along the 2NF sections it is not allowed to slit the fabric at the places of the edges of the sections, and also sag of the sections themselves is not allowed.

4. In the case of misalignment of the 3NF plate during its seaming into 2NF sections it is permitted to cut off the plate and place the separate following piece with dimension not less than 400 mm.

Note. During repair of the fabric covering of wings and empennage it is necessary to follow recommendations and instructions of the manufacturer.

The Technological Process of Covering of Units with Fabric and Paint

The order of execution of the operations is given in Table 22.

Table 22.

Designation of Operations	Method of Applying the Coating	Holding Time hr. min.	Temperature °C.
Removal of dirt and dust from the frame and degreasing...............	–	–	–
Priming of the frame with 138A glyptal primer along rivets and the damaged places.....................	By brush	8.00	12-17
Coating of duralumin skin with AK-20 glue..............................	The same	0.30-0.40	12-35
Fastening of fabric:			
widths are sewn so that the base of the fabric and seams would be parallel to the ribs.............	–	–	–
fabric is stretched like a "stocking," is glued on the frontal skin and pinned along the edges	–	–	–

Table 22 (continued)

Designation of Operations	Method of Applying the Coating	Holding Time hr. min.	Temperature °C.
the fabric is fastened to the ribs and the trailing edge with 3NF strips...........................	—	—	—
Gluing of fabric with airplane dope AlN of the first opening[1] along the trailing-edge skin.................	By brush	0.45-1.00	12-35
Sewing of fabric on the tip.........	—	—	—
Coating of the entire surface of fabric with the first layer of AlN..	By brush	1.00	12-17
Coating with the second layer of AlN of the entire surface of fabric.....	The same	1.00	12-17
Sticking of washers, tapes and patches with simultaneous application of the third layer of AlN......	—	2.00	12-17
Coating with the fourth layer of AlN	By brush	1.00	12-17
Stripping of surface with sandpaper and removal of dust................	—	—	—
Application of the fifth layer of AlN................................	By brush	3.00	12-35
Sticking of 29SN celluloid washers to drain holes with AlN dope........	—	—	—
Stripping of the surface with sandpaper, removal of dust with a brush.	—	—	—
Application of AGT-4 on the top surface...........................	By brush	2.30	12-17
Application of AGT-16 (gray-blue color) on the bottom surface........	The same	2.30	12-17
Painting of insignia and reference points............................	"	2.30	12-17

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[1] [Translator's Note: Believe this word should be coating, even though the word for opening was used.]

§ 52. CARE OF WINDOWS OF THE COMPARTMENTS

Wipe the plexiglass with clean and soft cotton cloth, chamois or flannel, slightly moistened in soapy water. Remove grease spots from the surface of glass with cotton rags moistened in kerosene. Never use aviation gas, acetone, paint remover and airplane dopes because they soften the surface of the glass and cause its cloudiness.

During the inspection of windows be guided by the following:

1) replace the window glasses when there are cracks and cloudiness on them;

2) replace rubber gaskets when there are ruptures and they fall out of grooves of the windows.

§ 53. POSITIONING OF THE AIRCRAFT ON JACKS

For lifting the aircraft during maintenance of the airframe plant applies jacks to the set of ground equipment: two front – for lifting the aircraft during maintenance of the landing gear, one – rear – for maintenance of the tail installation and one – for removing the landing gear wheels (Fig. 207). The front jacks are installed under special steel seats (supports) located on the front spar of the wing center section opposite the airplane struts of frame No. 6. The tail jack is installed under the support located on frame No. 26. The jack for freeing the wheels from load is installed under the seat mounted on the attachment bolt of the forward brace strut to the half-axle.

With the use of jacks it is possible to perform four versions of lifting the aircraft:

1) lifting the forward section of the aircraft by the two front jacks for freeing the landing gear from load;

2) lifting the tail section of the fuselage by one rear jack for freeing the tail wheel installation from load;

3) lifting the entire aircraft at three points by the front and tail jacks,

4) lifting the right or left side of the aircraft for freeing the landing gear wheels from load when performing periodic servicing.

It is permitted to raise the aircraft with wind velocity not more than 6 m/s.

Fig. 207. Positioning of the aircraft on jacks.

When lifting the aircraft it is necessary to provide reliable restraint of the landing gear wheels or tail wheel by chocks to avoid shift of the aircraft and its falling from the jacks.

When lifting the aircraft simultaneously by three jacks it is necessary to observe the following sequence: first raise the forward section of the aircraft, and then the tail. For protection from slipping of the support from the shaft of the jack as well as for elimination of list of the aircraft when lifting the front jacks should be raised evenly.

Lift the tail section of the fuselage with positioning of the aircraft in the line of flight by blocks and tackle or by a crane. For protection from tumbling of the aircraft on the nose it is necessary to install a counterweight on the tail section of the fuselage at frame No. 20.

When lifting the aircraft do not allow people walking inside the aircraft.

In the case of breakage of the landing gear during landing for lifting the aircraft it is necessary to lay a wooden foundation, upholstered at the point of contact with the bow of the wing center section with a layer of felt 10-15 mm thick, under the rib of the wing center section, at the junction point with the lower wing.

When lifting the aircraft by jacks, installed under the ribs of the wing center section, between the shaft of the jack, the head of which is ball-shaped, and the foundation one should lay a metal pad 10-12 mm thick. The pad should have minimum overall size 100 × 300 mm with recess in the middle for rest of the ball end of the shaft.

If the stroke of the jack shaft is insufficient for lifting the aircraft to the necessary height, perform lifting in two or three stages, periodically increasing the platforms under the jack. Upon completion of the following lift for changing the positions of the jack the aircraft is placed on stands, lined with wooden beams and connected together by clamps for elimination of the slipping of beams relative to each other.

Before lifting the aircraft it is necessary to free it from load, drain fuel and oil from the tanks and secure the tail section of the fuselage with braces.

§ 54. TOWING THE AIRCRAFT

When towing the aircraft within limits of the airfield by a truck or tractor it is necessary to fulfill the requirement of the corresponding sections of "Aviation engineering service manual" and "Instructions for towing of An-2 aircraft."

For the towing of aircraft the following devices are used; towing and steering arm and tow cable.

The towing and steering arm is designed for towing aircraft with the nose forward and pressing back when rolling (placing) the aircraft into a hangar.

The towing and steering arm consists of two tubes, to the rear ends of which are attached the shock absorber containers, and to the front – a lug. Inside the shock absorber containers are installed rods with a set of rubber rings. To the free ends of the rods are fastened rods with hooks and clamps for connection to the tow rings of the front landing gear struts.

The rods are connected to the shock absorber rods of the towing and steering arm by check bolts, which with excessive forces being transferred from the tower, will be sheared, which protects the landing gear from large loads. Spare check bolts are stored inside the hollow rods. The towing and steering arm has two wheels and a crossbeam, which connects the free ends of the rods which serve for transporting the towing and steering arm on the airfield behind the tractor. When towing the aircraft the crossbeam is installed along the left rod and is fixed in this position with a pin.

Basic specifications of the towing and steering arm.

Wheel track during transportation, mm........	800
Shear force of the check bolt, kgf...........	1050 + 50
Number of check bolts, pcs...................	2
Number of spare check bolts, pcs.............	8

The tow cable is intended for towing the aircraft with the nose forward and consists of two cable runs with hooks and a clevis on the ends. The cable is connected by hooks to the eyelets of the front landing gear struts, and by lug – to the drawbar hook of the tower. For turning the aircraft when towing there is a special guiding fork with a rod, which is installed on the axle of the tail wheel and is fastened with a clamp nut.

When towing the aircraft it is necessary to fulfill the following requirements:

1) before towing release the parking brake;

2) start towing the aircraft smoothly, without jerks, to avoid overloads;

3) when towing in the cockpit there should be a pilot or technician, who has the responsibility for towing and wheel brake control of the aircraft;

4) on the tractor for transfer of instructions to the driver, received from the pilot or technician, located in the cockpit of the aircraft, there is placed an aircraft mechanic or engine mechanic, who also monitors the safety of towing the aircraft;

5) the aircraft must be towed without jerks and sharp turns;

6) when towing with the aid of cables the turn angle of the tractor relative to the aircraft should not exceed 60° in each direction, and the speed of the tractor and aircraft should not exceed the speed of a walking man;

7) when towing the aircraft past buildings and other obstacles at the cantilevers of the lower wing there should be escorts to protect the wings from touching obstacles;

8) make the starting and stopping of the motion of the tractor smooth.

For stopping the motion of the aircraft being towed first the tractor is stopped and as it is stopped there is accomplished braking of the aircraft. It is permitted to brake the aircraft only in cases of the breakage of towing equipment or in cases of possible collision with obstacles.

When towing on a cable (soft) coupling it is necessary to see that the cable does not touch the wheel casings and that the landing gear wheels do not run into the cable.

CHAPTER X

MODIFICATIONS OF AN-2 AIRCRAFT

Besides An-2 aircraft, there are its following modifications:

An-2V seaplane;

An-2P fire-fighting aircraft;

An-2M agricultural aircraft.

§ 55. AN-2V SEAPLANE

The An-2V aircraft on float-type landing gear (Fig. 208) is intended for operation on local air lines in river, lake and coastal sea areas as a transport plane, on which there are transported loads weighing up to 1000 kg or nine passengers, and it is also used as a reconnaissance aircraft for ice, fish, sea animals, etc.

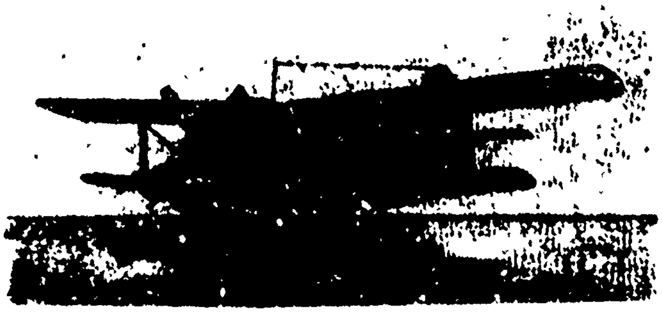

Fig. 208. An-2V aircraft.

Basic Specifications

The geometric dimensions of the An-2V aircraft are shown in Fig. 209.

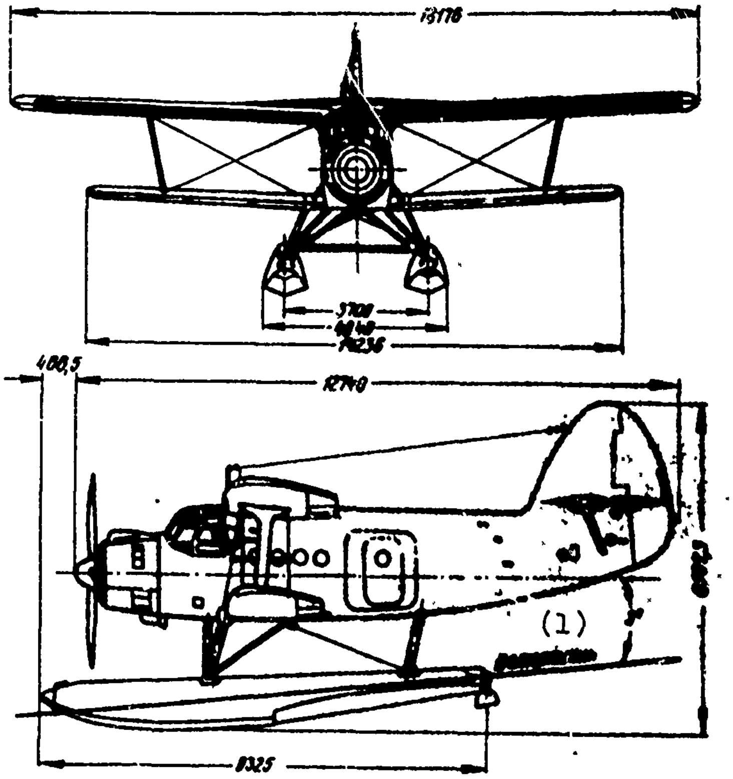

Fig. 209. Geometric dimensions of the AN-2V aircraft.

KEY: (1) Waterline.

Weight and center of gravity data.

Maximum takeoff weight, kg:	
at free-air temperature on the ground not higher than +20°C	5250
at free-air temperature on the ground above +20°C	5000
Basic aircraft weight, kg:	
up to 60 series	3666

from the 60 series	3688
C.g. position of basic aircraft, % of MAC:	
up to 60 series	19.6
from the 60 series	19.2
Limiting operating c.g. position of the aircraft, % MAC:	
forward	17.0
aft	27.0
Maximum allowable number of passengers	9
Maximum payload (with takeoff weight 5250 kg), kg	1000
The c.g. distance of basic aircraft from frame No. 5, m:	
up to 60 series	0.495
from the 60 series	0.485

Basic specifications of V-514-D8 reversible-pitch propeller

Type of propeller	automatic, reversible, in-flight variable pitch.
Scheme of action	direct with use of a second channel for reversing.
Operating principle	hydrocentrifugal
Direction of rotation	right
Propeller diameter, m	3.6
Number of blades	4
Maximum blade angle at radius 1000 mm.	31° + 2°30'
Minimum blade angle at radius 1000 mm.	16° ± 15'
Angle of the reversible position of blades	-7° ± 15'
Blade turning range	15° + 2°30'
Balance-weight angle	20° ± 1°
Regulator	RV-101
Working fluid	Motor oil
Weight of propeller, kg	180.7

Takeoff and landing data (gross weight 5250 kg)

Takeoff at nominal engine operating mode:	
a) without use of flaps:	
unstick speed, km/h	120-125
takeoff run, m	400
b) with flaps deflected 20°:	
unstick speed, km/h	95-100
takeoff run, m	240
Takeoff at maximum (takeoff) mode:	
a) with flaps deflected 20°:	
unstick speed, km/h	90-95
takeoff run, m	200
b) with flaps deflected 30°:	
unstick speed, km/h	85-90
takeoff run, m	180
Landing (aircraft weight 5000 kg):	
a) with flaps deflected 30°:	
landing speed, km/h	95
landing run, m	200
b) with flaps deflected 20°:	
landing speed, km/h	105
landing run, m	240

Note. Takeoff and landing data are provided for standard atmospheric conditions and for calm.

Basic flight data (gross weight 5250 kg)

Maximum speed of horizontal flight, km/h:	
near the ground	223
at critical altitude (1600 m)	233
Rate of climb near the ground at nominal engine operating mode, m/s	2.6
Cruising speed (indicated), km/h	from 155 to 170

Flight limitations

Maximum gross weight of aircraft, kg:	
at free-air temperature near the ground not above +20°C	5250
at free-air temperature near the ground above +20°C	5000

Note. Total weight 5000 kg at elevated free-air temperatures near the ground is limited from conditions of providing the permissible engine temperature conditions.

Maximum allowable number of passengers (limited by conditions of maintaining the permissible c.g. position)	9
Maximum payload at gross weight 5250 kg , kg.	1000
Allowable c.g. position, % MAC:	
maximum forward	17.0
maximum aft	27.0
Maximum allowable wind velocity, m/s:	
for taxiing, takeoff and landing	16
cross wind for takeoff and landing at 90° angle to the landing pattern	5
Maximum height of wave for takeoff and landing, m	0.7
Maximum aircraft towing speed:	
in calm, km/h	up to 20
with wave height over 0.3 m and wind velocity over 6 m/s, km/h	up to 10
Maximum flap deflection, degrees:	
for takeoff and landing with wind up to 10 m/s	30
for takeoff and landing with wind from 10 to 16 m/s	20
Minimum permissible depth of water for takeoff and landing, m	1.2-1.9
Minimum permissible depth of water for taxiing and maneuvering, m	0.85-1.55
The dimensions of the flight strip of the water surface at standard conditions, m:	
for gross weight above 5000 kg	850 × 80

for gross weight up to 5000 kg............ 800 × 80

To avoid icing the operation of the An-2V aircraft is permitted at free-air temperatures, °C.. not below 0

Structural Distinctions of the An-2V Aircraft from the An-2

Airframe

1. On the fuselage at frames Nos. 8 and 15 there are installed the mounting lugs of struts and braces of the float-type landing gear.

2. At frame No. 26 there is installed the assembly under the cow locks.

3. The mounting lugs of the cargo boom on frames Nos. 15 and 16 and reinforcement under them are installed. .

4. In the fuselage are provided places for securing sea equipment, cabin steps, coat racks, drinking tank, etc.

5. The inspection hatches of the lower wing, the fillets of the biplane strut joints and the headlight hatches are hermetically sealed.

6. On the mounting lug joints of the upper wing to the fuselage there are installed eyes, placed on corresponding elongated clamp bolts for lifting the aircraft with a crane.

7. Drain holes in the wings and tail surfaces are closed with caps.

8. The support is installed for fixing the open position of the cargo door.

9. In the cargo compartment between frames Nos. 13 and 14 there are added tie-downs for the box with aircraft tools.

Control and the Pneumatic System

1. On the left control column there is installed the pneumatic control valve of the front tow locks.

2. Additional line of the pneumatic system is installed and an electropneumatic valve is installed for control of prop reversing.

3. In the fuselage is mounted the cable control of raising the float controls and also the rear tow lock.

Power Plant

1. On the aircraft is installed a V-514-D8 reversible propeller.

2. On the cowling and fuselage is installed an insert for the installation of steps.

Special Equipment

1. The battery has been transferred to fuselage frame No. 15 and a place has been provided for its securing past frame No. 23 for the land version.

2. The airport power supply cord is elongated from 3 to 6 m.

3. On the fin and mast there have been installed bright lights.

Construction of the Float

The floats (Fig. 210) in their construction are identical and are interchangeable. The framework of each float consists of 31 frames, 30 stringers, located in the upper part of the float, 2 angular-shaped bilge sections, T-shaped keel section and duralumin covering.

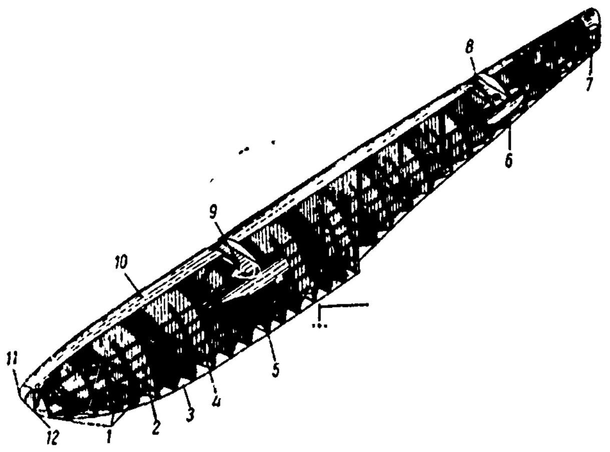

Fig. 210. Construction of the float: 1 – frames; 2 – stringers; 3 – bottom; 4 – blank frame (partition); 5 – frame No. 12 with dish; 6 – frame No. 26 with dish; 7 – frame No. 31; 8 – rear mounting lug of landing gear struts; 9 – front mounting lug of landing gear struts; 10 – covering of float; 11 – bilge section; 12 – keel section.

The frames of the float are divided into three groups: main frames Nos.12 and 26 with mounting lugs of landing gear struts, blank frames, serving as watertight bulkheads, and normal frames.

The collection of frames is made of sheet duralumin and pressed sections. Frame No. 12 in the zone of bilge stringers is reinforced by cover plates and brackets. On frame No. 12 are placed the mounting lugs of the rolling bogie.

The attachment joints of the main frames are made of 30KhGSA Chromansil steel. The rivet seams of blank and main frames are hermetically sealed with UPL thiokol tape and UZ thiokol putty.

The covering of the float is made of sheet duralumin from 0.8 to 1.2 mm thick and is riveted to the frame of the float by cup-head rivets. The riveting of the skin on the hydroplaning part of the bottom is done with flush rivets. The rivet seams of the skin, blank and main frames are sealed by AST-100 tape, impregnated with red lead on drying oil.

The bilge and keel sections are installed on the outside of the bottom covering for protecting the covering from damages during operation of the aircraft on shallow water and during movement on the shore. The connection of the keel and bilge sections on the step is accomplished by steel and duralumin brackets. Along the entire length of the float on the ridge of the keel section there is placed edging, replaceable in case of wear during operation.

In the upper part of the float from frame No. 3 to frame No. 26 to the skin are attached two inverted U-shaped sections, serving as foot supports when walking on the float. Each float is divided into 12 watertight compartments, which ensure the unsinkability of the aircraft with flooding of two adjacent compartments of any part of the float.

On top the sheets of the skin in every compartment have cutouts, reinforced by edgings of grommets and repair hatches. The grommets are interchangeable. Sealing of the grommets is ensured by easily removable rubber rings.

The forward section of the float terminates with a buffer, covered with canvas. The top of the aft end of the float has a cutout for the pneumatic cylinder of the water rudder, closed by a detachable fairing. On each float in the nose there is installed a tow lock. On the float there are four tie-down rings and three cleats.

For protection from corrosion all the duralumin parts are anodized, primed and painted with oil-base enamels, and the remaining parts are cadmium-plated.

The total float displacement ensures 100% reserve buoyancy at aircraft gross weight 5250 kg. The weight of the float is 220 kg. The dimensions of the float: length 9.38 m, width 1.14 m, height 1 m.

Water Controls

The water controls installed in the aft ends of the floats are thick duralumin plates, attached with the aid of brackets to a vertical tubular axle. In the upper part of the axle is installed the actuating arm, connected with the rod of the pneumatic cylinder. The double-action pneumatic control cylinder has direct and reverse stroke.

The controls are controlled from the pneumatic control system of the wheel and ski brakes. For this purpose the pneumatic cylinder is connected to the compressed air bottle through the PU-7 valve, with which pressure is regulated in the control system of the water controls from 6 to 10 kgf/cm^2. With pressure on the brake switch, installed on the left steering control of the aircraft, the water controls operate in conjunction with the rudder. The angle of deflection of water controls ±20°.

For protection of the controls from breakage the rudder blade is made rising. The rudder is held in the operating lower position by force of weight and by two spiral springs.

The tow locks are controlled by the direct-action pneumatic cylinders, which are installed on the common brackets of the locks. The locks open by a pneumatic valve installed on the left steering control, and they shut by hand.

Landing Gear Truss

The landing gear truss (Fig. 211) consists of front struts with braces, rear struts with connecting brace and six bracing strips. All the rigid elements of the truss are made of drop-shaped steel tubes.

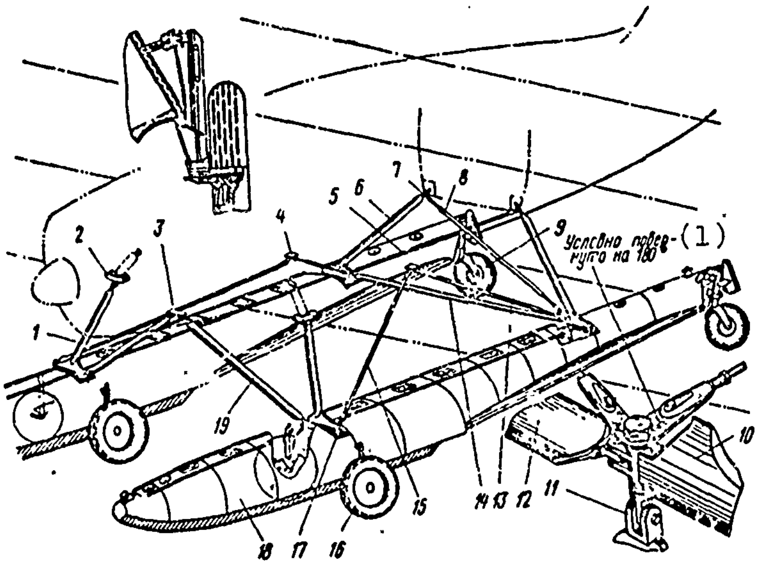

Fig. 211. Landing gear truss: 1 – front strut; 2 – mounting lug of the front strut to the pyramid of the wing center section; 3 – joint on fuselage frame No. 4; 4 – joint on fuselage frame No. 8; 5 – bracing strip No. 11; 6 – rear strut; 7 – mounting lug of rear strut to fuselage frame No. 15; 8 – bracing strip No. 11; 9 – rear wheel of rolling bogie; 10 – cross-member of rear strut; 11 – mounting lug of rear strut to float; 12 – brace; 13 – bracing strip No. 9; 14 – brace; 15 – bracing strip No. 14; 16 – front wheel of rolling bogie; 17 – mounting lug of front strut to float; 18 – float; 19 – brace strut.

KEY: Conditionally turned 180°.

The front landing gear struts are attached to the truss of the wing center section on the wheel-type landing gear joints. The bracing struts will approach the mounting shoe of the brace struts of the wheel-type landing gear, installed on fuselage frame No. 4. The rear struts are fastened to detachable eye bolts, screwed into cast sole pieces installed at the bottom of frame No. 15. Each strut is fastened to the float with two bolts.

The bracing strips on the fuselage are fastened to detachable steel joints installed under the struts of frame No. 8. Lateral bracing strips: front No. 14, rear No. 9 and bracing strips of rear cross No. 11. Tension of bracing strips with assembly on the ground and after descent of the aircraft to the water is provided in Table 23.

Table 23.

Number of bracing strip	Tension of bracing strip, kgf	
	with assembly on the ground	after descent of aircraft to the water
9	465^{+200}_{-50}	not over 800
11	690 ± 50	" " 690
14	1140 ± 50	" " 2000

The struts and bracing strips of the right side are interchangeable with the same parts of the left side of the truss. The junction places of struts and bracing struts with floats are enclosed by detachable fairings. All parts of the landing gear truss have an anticorrosive coating.

Pneumatic System

The pneumatic system (Fig. 212) with float-type landing gear is designed for control of the nose tow locks, water controls and prop reversing.

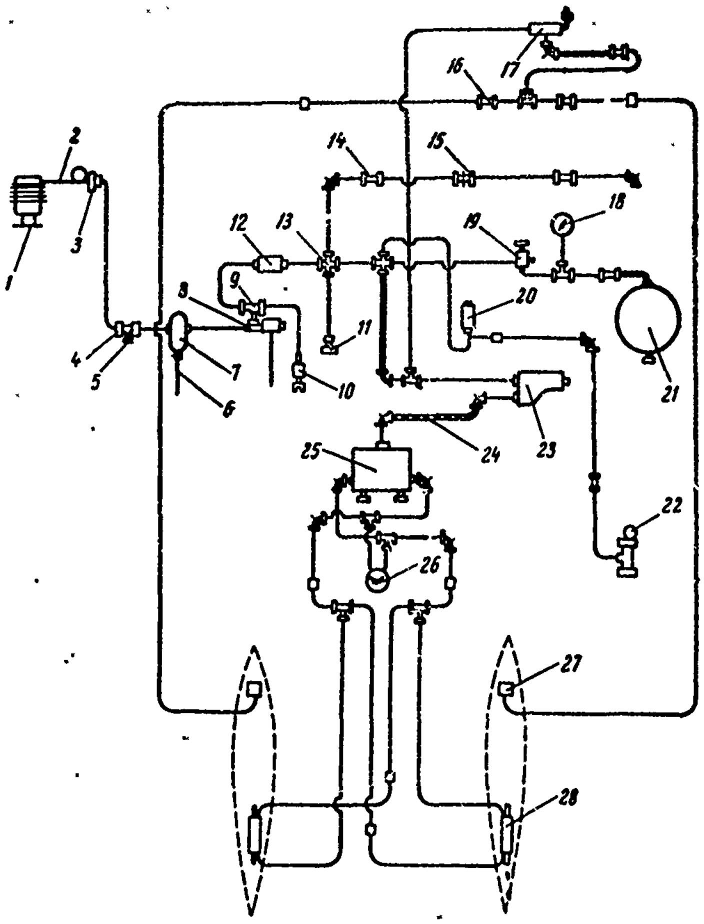

Fig. 212. Schematic diagram of the pneumatic system of the An-2V aircraft: 1 – AK-50M compressor; 2 – line; 3 – flanged elbow; 4 – passage tee; 5 – plug; 6 – sediment drain tube; 7 – FT-9900 sump filter; 8 – AD-50 automatic pressure control; 9 – tee with check valve; 10 – charge fitting with check valve; 11 – recharge fitting; 12 – direct-flow filter; 13 – four-way passage fitting; 14 – passage fitting; 15 – flanged fitting; 16 – flanged elbow; 17 – pneumatic valve; 18 – 80 kgf/cm^2 MV-80 manometer; 19 – KN-50 filling cock with safety valve; 20 – EK-48 electropneumatic valve; 21 – aircraft bottle with compressed air with volume 8 *l*; 22 – RV-101 prop regulator; 23 – PU-7 reducing valve; 24 – medium pressure armored rubber hose; 25 – PU-8/1 differential; 26 – 12 kgf/cm^2 two-pointer manometer; 27 – nose tow lock; 28 – float rudder control pneumatic cylinder.

The nose tow locks are controlled by an air cock installed in the upper part of the left control column.

The water controls are controlled by pressure of the switch on the left steering control to the pusher of the PU-7 valve, from where air through the PU-8/1 differential enters the control cylinders of the water controls. The water controls operate in conjunction with the aircraft rudder.

Control of prop reversing is mixed – air and electric, it is accomplished by electropneumatic valve EK-48, installed on fuselage frame No. 1. The EK-48 valve is connected to the air gate, screwed into the housing of the RV-101 speed regulator on the engine, which actuates the V-514-D8 prop reversal. Control of the EK-48 valve is electrical. The prop reversal control system is actuated by the AZS-10 circuit breaker, installed on the central panel of the instrument display. Actuation of the circuit breaker is accompanied by ignition of the SLTs-51 signal light, installed next to it. The button is covered by a protective cap.

Exit from the reversing position is accomplished by pressing the button on the top cover of the left control column.

Cable Control of Raising the Water Controls and Rear Tow Lock.

On the An2V aircraft in addition to the cable control of the aircraft and engine there is mounted cable control of the raising of water controls and the rear tow lock installed in the tail section of the fuselage. The raising of controls is controlled by a handle with cable, installed on a bracket attached to the right side of the fuselage between frames Nos. 3 and 4. The rear tow lock is controlled by movement of the handle with cable, located on fuselage frame No. 5 in its upper part.

The rear tow lock is fastened to a U-shaped joint, riveted between fuselage frames Nos. 25 and 26, and is a steel hook, which is opened by turning the lever connected with cable, and the lock is closed by hand.

§ 56. An-2P FIRE-FIGHTING AIRCRAFT

Fires, as a rule, appear near wooded basins, not far from rivers and lakes. Hence it follows that wood fires can be put out by water, using the An-2V seaplane for this purpose. On the basis of this aircraft the An-2P was created (Fig. 213) for the extinguishing and localization of fires.

On the An-2P aircraft were imposed requirements:

1) to preserve its universality, i.e., the possibility of utilization as a patrol, passenger or cargo aircraft;

2) fire-fighting equipment should possess minimum weight and be placed outside the cargo-passenger compartment of the aircraft.

Fig. 213. Fire-fighting aircraft An-2P.

For the satisfaction of these requirements and in order not to use external under-wing tanks, which disturb the aerodynamics of the aircraft, as containers for water it was decided to use compartments in the center section of hydro-floats with capacity 630 l each.

The Design Features of the An-2P Aircraft

For taking on water in the bottoms of the floats there are set up small scoop-like intake flaps and wide flaps opening to the sides, which provide rapid draining of water on the source of the fire.

Intake flaps, opening forward in the direction of movement of the aircraft, during its hydroplaning across the water surface at speed 45-50 km/h provide complete filling (Fig. 214a) of the compartments of floats with water under hydraulic head in 5-7 sec. After filling of compartments with water the flaps are closed automatically. The draining of water (Fig. 214b) is also automatized and is performed in three seconds at speed 150-160 km/h.

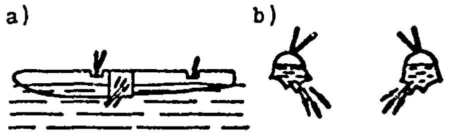

Fig. 214. Diagram of taking on and draining water: a) taking on water; b) draining water.

Into the compartments of the floats are inserted the ends of lines, which go from two small tanks for wetting agent – solution of NP-1 sulfanole, located in the tail section of the fuselage (to every 1000 *l* of water there are added 10 *l* of 30-percent solution of NP-1 sulfanole). After the addition of sulfanole into the water it no longer rolls from objects, but is rapidly absorbed by them. Furthermore, such "wet" water passes through the tops of trees considerably easier.

Fire-Fighting Equipment

The complete set of fire-fighting equipment of the An-2P aircraft (Fig. 215) includes:

water take-on button 1, installed on the aircraft commander's steering control;

penumatic water drain valve 2;

valve 4 for draining a dose of wetting agent;

dosimeter line 5;

valve 6 for preparation of the dose of wetting agent;

two small tanks 7 for wetting agent, located in the tail section of the fuselage;

water level floats-transmitters 8 in the hydro-float compartments;

magnetic valves and pneumatic cylinders for opening and closing the intake flaps;

pneumatic cylinders for opening and closing the drain flaps;

The weight of the complete set of fire-fighting equipment of the An-2P aircraft – 94 kg.

Intake and Drain of Water

During the hydroplaning of the aircraft across the water surface the pilot presses button 1 installed on the steering control (see Fig. 215). In this case the magnetic valves are actuated, which open the access of compressed air to the pneumatic cylinders. The pneumatic cylinders lower the intake flaps and water under the action of dynamic pressure rushes into the compartments of the hydro-floats and fills them.

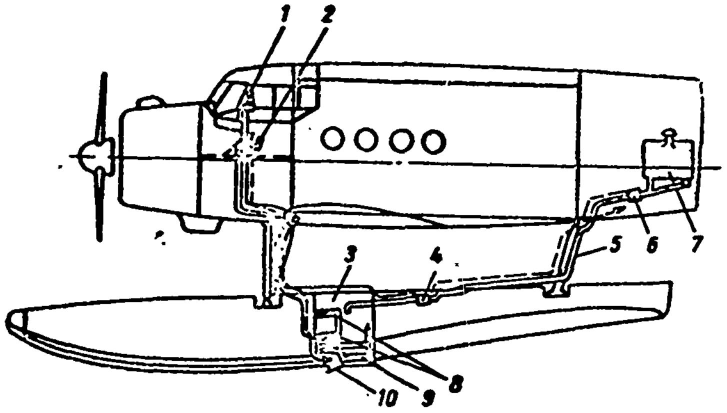

Fig. 215. Diagram of the fire-fighting equipment of the An-2F aircraft: 1 – water take-on button; 2 – pneumatic water drain valve; 3 – compartment for water; 4 – valve for draining a dose of wetting agent; 5 – dosimeter line; 6 – valve for preparation of the dose of wetting agent; 7 – small tanks for wetting agent; 8 – water level floats-transmitters; 9 – drain flaps; 10 – intake flaps.

The quantity of water being taken on into the compartments of the hydro-floats is determined depending on the weight of the fuel present in the aircraft tanks. When the fuel supply in the tanks is still sufficiently great and in order to avoid overloading the aircraft, the taking on of water is limited to a minimum portion – 600 *l*. Then as the fuel supply decreases this portion is first increased to 1000 *l*, and after that – to 1260 *l*.

The taking on of water into the compartments of hydro-floats is automatized. For this purpose in the compartments for water there are installed activated by the pilot in the electrical circuit 300 and 500 *l* liquid level floats-transmitters 8, which corresponds to the total amount of water 600 and 1000 *l* in the hydro-floats of the aircraft.

As soon as the water level in the compartments of hydro-floats reaches marks 300 or 500 *l*, the floats-transmitters automatically actuate the pneumatic cylinders to raise (close) the intake flaps and the taking on of water in the compartments of the hydro-floats is ceased, which the pilot is informed by signal lights on the panel. If the transmitters are not preliminarily turned on, then the aircraft takes on the maximum portion of water – 1260 *l*.

During flight to the place of the fire the pilot pours the appropriate dose of wetting agent into the compartments with water. This dose is determined by the dosimeter line 5, located between valves 4 for draining wetting agent into the compartments and valves 3 for preparation of dose. These valves are synchronized – at the moment of opening of drain valves the valves for preparation of dose are automatically closed. With approach to the place of the source of fire the observer sitting next to the pilot will turn the handle of the pneumatic water drain valve 2, the pneumatic cylinders actuate and the wide water drain flaps will open, in this case in 3 sec. the compartments of the floats will be empty. Having shut off the pneumatic water drain valve (valve 6 for preparation of the dose of wetting agent in this case is automatically opened), the pilot prepares the dose of wetting agent for the following portion of water.

The flight altitude when draining the water – 10 m, the strip of moistened soil cover – 70-80 m, and width – 12-14 m, water concentration on the soil cover – 0.8-1 l/m^2.

§ 57. AN-2M AIRCRAFT

The specialized agricultural aircraft An-2M is a modification of the An-2. It is designed for performing the following aircraft chemical operations in agriculture and forestry:

introduction of fertilizers;

combating pests and diseases of plants;

combating weedy vegetation;

defoliation and desiccation of the cotton plant and others.

During the separate periods of the year, when aircraft will not be occupied in aircraft chemical operations, it is possible to use it in the transport version for the transportation of cargo (with the removal of agricultural equipment), and also for the transportation of passengers with the installation of easily removable light-weight seats.

The An-2M aircraft is a biplane of metal construction with nonretractable landing gear and a single-fin empennage (Fig. 216). On the aircraft is mounted the ASh-62M air-cooled radial carburetor engine with automatic tractor propeller AV-2 of series 02 with increased thrust characteristics.

Fig. 216. An-2M aircraft.

For expanding the cg position range of the aircraft the area of the horizontal tail surfaces has been increased to 8 m^2. The anti-nose-over angle of the aircraft is increased because of the stagger of the wheels of the main landing gear forward by 70 mm. For easing the takeoff with a cross wind the tail wheel is locked in the neutral position. The aircraft control is single, the run is mixed, made with rigid rods and with cables.

The increase in the economy of the An-2M aircraft as compared with the An-2 is achieved by the creation and the placement on it of new highly productive agricultural equipment, an increased tank for chemicals, and also because of the reduction of the number of crew members.

A feature of aircraft is the presence on board of a powerful energy unit – KPM gear box, installed in the forward section of the fuselage and driven from the ASh-62M engine.

Besides the new agricultural equipment and the gear box, the An-2M aircraft has other distinctions from the An-2:

the flight deck is isolated from the cargo compartment by means of sealing the bulkhead and the door on fuselage frame No. 5;

in the cockpit canopy on the left side there is an entrance hatch;

in the cockpit there are installed a seat and aircraft controls for only one pilot, and instead of the copilot's seat a seat is installed for the aircraft technician;

the flight deck has an airconditioning system;

the constructions of the cowling and engine are improved.

On aircraft is installed minimum electrical and radio equipment, which facilitates the performance of agricultural operations and ferrying the aircraft to the working area. Figure 217 depicts the layout diagram of the An-2M aircraft.

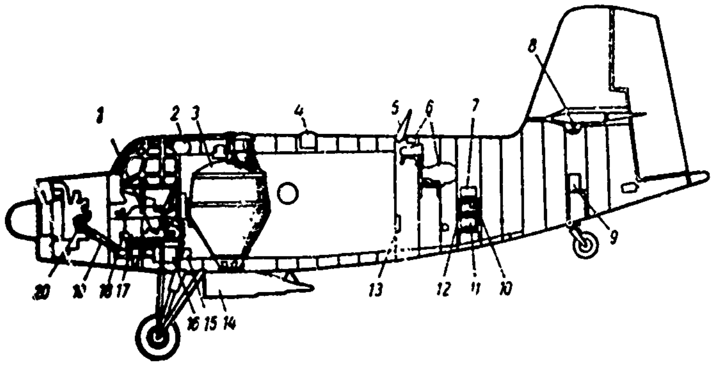

Fig. 217. Layout diagram of the An-2M aircraft: 1 – AOS-81M automatic machine; 2 – evaporator of conditioner; 3 – tank for chemicals; 4 – loop antenna of ARK-9; 5 – antenna of AMS-1; 6 – units of conditioner; 7 – ultrashortwave radio; 8 – antenna of radio altimeter; 9 – battery; 10 – power unit of ARK-9; 11 – radio altimeter; 12 – ARK-9 radio receiver; 13 – panel of the pneumatic control system of agricultural equipment; 14 – tunnel-type sprayer; 15 – PO-250 converter; 16 – KPM-R bevel gear box; 17 – KPM-K gear box; 18 – PT-1250Ts converter; 19 – power shaft; 20 – KPM-P reducer.

Basic Technical Data

Geometric data

Basic dimensions of the aircraft are given in Fig. 218.

Length of aircraft at rest, m	12.95
Height of aircraft in the line of flight, m	5.95
Length of fuselage, m	10.12
Span of wing center section, m	2.68
Dimensions of cargo compartment, m:	
length	4.10
width	1.60
height	1.80
Elongation of fuselage	5.04
Dimensions of the cargo door, m:	
width	1.65
height	1.67

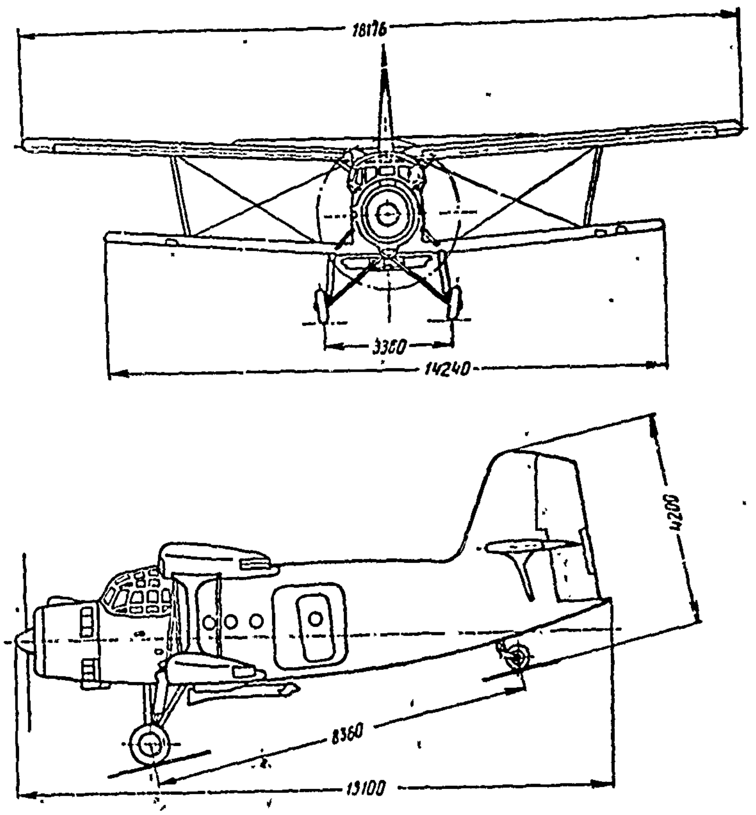
18176
3360
14240
4200
8360
13100

Fig. 218. Diagram of the An-2M aircraft.
Front and side view.

Size of the entrance door of the cargo compartment, m:	
width	0.81
height	1.42
Size of the entrance hatch in the cockpit canopy, m	0.535 × × 0.935

Wings

Span of upper wing, m	18.176
Span of lower wing, m	14.26
Area of upper wing with fuselage part, m^2	43.55
Area of lower wing with center section, m^2	28.55
Span of the detachable part of the upper wing (from the axis of attachment joints to the edge of the tip), m	8.425
Span of the detachable part of the lower wing, m.	5.795
Chord of upper wing, m	2.45
Chord of lower wing, m	2.00
MAC of wing, m	2.269
Aspect ratio of upper wing	7.70
Aspect ratio of lower wing	7.25
Length of aileron, m	4.692
Area of aileron, m^2	5.90
Aileron chord, m	0.65
Aerodynamic balance of aileron, %	21.7
Area of aileron trim tab, m^2	0.141
Length of one flap of the upper wing, m	3.415
Area of flaps, m^2	4.09
Chord of flap, m	0.60
Aerodynamic balance of the flap, %	23
Flaps of lower wing:	
length of root flap, m	3.16
length of tip flap, m	2.32
area of flaps, m^2	5.50
chord of flap, m	0.5

aerodynamic balance of flap, %	23
Length of one slat, m	3.85
Area of slats, m^2	4.39

Elevator unit

Span of elevator unit, m	8.00
Area of elevator unit, m^2	15.10
Area of stabilizer, m^2	8.13
Area of elevator, m^2	6.67
Area of elevator trim tab, m^2	0.32
MAC of elevator unit, m	1.95
Elevator chord, m	0.893

Rudder unit

Height of rudder unit, m	3.285
Area of rudder unit (without fuselage part), m^2	5.04
Area of fin (without fuselage part), m^2	2.70
Area of rudder, m^2	2.34
Area of aerodynamic balance of the rudder, m^2	0.536
Area of rudder trim tab, m^2	0.119

Control data of the aircraft

Upper wing angle	3°
Lower wing angle	1°
Dihedral:	
upper wing	3°
lower wing	4°19'
Stabilizer angle (relative to the longitudinal datum line of the aircraft)	0°
Ground angle of the aircraft	10°40'

Anti-nose-over angle:	
with position of center of gravity 29% MAC..	32°30'
with position of center of gravity 17.2% MAC	28°40'

Deflection of controls

Flap deflection (down)	$30^{\circ}{}^{+1^{\circ}}_{-1^{\circ}5}$
Hanging (down) of ailerons with lowering of flaps to 30° ± 1°	$17^{\circ}{}^{+1^{\circ}5}_{-1^{\circ}}$
Flap deflection:	
during takeoff	25-30°
during landing	30°
Aileron deflection with undeflected flaps:	
up	$30^{\circ}{}^{+1^{\circ}}_{-1^{\circ}5}$
down	$14^{\circ}{}^{+1^{\circ}}_{-1^{\circ}5}$
Aileron deflection with flaps deflected 30° (relative to the raised position of ailerons):	
up	$25.5^{\circ}{}^{+1^{\circ}}_{-1^{\circ}5}$
down	$14.5^{\circ}{}^{+1^{\circ}}_{-1^{\circ}5}$
Deflection of aileron trim tab:	
up	24° ± 1°
down	24° ± 1°
Elevator deflection:	
up	40° ± 1°5
down	22°5 ± 1°
Deflection of elevator trim tab:	
up	14° ± 1°
down	14° ± 1°
Rudder deflection:	
to the right	28° ± 2°
to the left	28° ± 2°

Deflection of rudder trim tab:

to the right..................................	14° ± 1°
to the left...................................	14° ± 1°

Note. With balanced position of the trim tabs of the elevator, rudder and aileron respectively the green signal lights on the central panel light up.

Weight and c.g. data

Maximum takeoff (above the takeoff weight for starting, engine testing and taxiing there is added 11 kg of fuel), kg.........................	5500
Maximally permissible landing weight, kg..........	5500
Normal landing weight, kg.........................	5250
Maximum payload (chemicals, cargo, passengers), kg	1500
Service load, kg..................................	130
Including, kg:	
pilot.......................................	80
oil...	50
Maximum fuel supply $\gamma = 0.755$ g/cm^3, kg...........	900
Maximum allowable forward c.g., % MAC:	
for agricultural version....	17.0
for transport version......	22.0
Maximum allowable aft c.g., % MAC:	
for agricultural version....................	33
for transport version.......................	34
Basic aircraft weight, kg:	
with permanent agricultural equipment and tank for chemicals (for calculations take the data from the aircraft logbook).............	3620 + 0.5%
in the version with rod-type sprayer.........	3700 + 0.5%
in the version with tunnel-type sprayer......	3680 + 0.5%
in the transport version....................	3620 + 0.5%

Capacities of the systems and basic operating data

Total fuel capacity, *l*	1200
Oil tank capacity, *l*	115
Maximum servicing of oil tank, *l*	85
Type of fuel and oil used:	
gasoline GOST 1012-54	B-91/115
oil GOST 1013-49	MS-20
Fuel consumption, kg/h:	
on aircraft chemical operations	145
in transport conditions	135
Oil consumption in operating condition, kg/*l*. s.h.	15
Fluid used for the shock struts of landing gear	Mineral oil AMG-10
Quantity of fluid in the shock strut, cm^3	1730
Quantity of fluid in the shock absorber of the tail wheel, cm^3	600
Pressure in shock struts, kgf/cm^2:	
landing gear	35 ± 1
tail wheel	32 ± 1
Pressure in the pneumatic tires of wheels, kgf/cm^2:	
landing gear	2.5-3
tail wheel	2.5-3
Pressure in the overall pneumatic system, kgf/cm^2	50
Air pressure in the brake system, kgf/cm^2	7-10
Pressure in the control system of the agricultural equipment, kgf/cm^2	25-35

Table 24.. Basic flight data under standard atmospheric conditions (takeoff weight 5500 kg, landing – 5250 kg).

Designation of data	Agricultural version		Transport version
	with duster	with sprayer	
Maximum speed of horizontal flight at nominal engine operating mode, kg/h:			
at sea level	196	196	235
at altitude 1000 m	200	200	242
at altitude 1750 m	–	–	250
Maximum rate of climb at nominal engine operating mode at sea level, m/s:			
flaps 0°	2.0	2.1	2.6
flaps 25°	2.0	2.0	2.8
Service ceiling at nominal engine operating mode, m	3200	3200	4100
Time of climb at flaps 0°, min.:			
altitude 500 m	4.2	4.0	3.2
altitude 1000 m	8.4	7.5_{-0}	$6.0^{+0.5}$
Practical flying range at altitude 1000 m and cruising speed 175 km/h with fuel load 600 kg, km	–	–	820_{-20}
Operating speed when performing aircraft chemical operations, km/h	160	160	–
Takeoff distance, m:			
at takeoff conditions (flaps 0°)	205	205	200
at nominal conditions (flaps 25°)	215	215	210
at nominal conditions (flaps 0°)	320	310	300
Landing distance at flaps 30° (energetic braking), m	135	140	150

Operational limitations of the aircraft

Maximum takeoff weight, kg	5500
Maximum allowable forward c.g., % MAC:	
for agricultural version	17.0
for transport version	22.0
Maximum allowable aft c.g. position, % MAC:	
for agricultural version	33.0
for transport version	34.0
Maximum allowable speed, km/h	250
Maximum design speed, km/h	300
Maximum speed with flaps extended, km/h:	
to 30°	150
to 25°	180
Minimum speed during climb at nominal engine operating mode(without the use of flaps), km/h	80-85
Maximum permissible angle of bank when performing agricultural operations, degrees	30
Maximum angle of bank during turns (without agricultural equipment), degrees	45
Maximum cross wind during takeoff and landing (being at 90° angle to the runway), m/s	6
Maximum permissible overload in the center of gravity of the aircraft in operation	3.5
Maximum permissible negative overload	1.85
Minimum speeds (at G = 5500 kg), km/h:	
V_{np} (at $\delta_3 = 0^\circ$)	110
V_{np} (at $\delta_3 = 30^\circ$)	100

Note. Minimum speeds are determined by complete deflection of the elevator (upward) and, consequently, depend on the center of gravity of the aircraft. In this case the values of minimum speeds are given for the average operational c.g. positions under engine "idling" conditions.

The Structural Distinctions of the An-2M Aircraft from the An-2

Fuselage. The aircraft is equipped with an air-conditioning system in the cockpit. For this the web of frame No. 1, which is the fire wall, is made of sheet 1 mm thick with hermetically sealed cutouts under the engine control rods. The cutouts on the web of frame No. 5 are also hermetically sealed.

The door on frame No. 5 has a round window, pressurization and a lock with a knob.

In the cockpit canopy (Fig. 219) on the left side there is an entrance door. The entrance door consists of two cast frames of VAL-5 material into which is placed SO-120 plexiglass 3 and 4 mm thick. On the lower part of the entrance door there is a window, which moves back along a milled guide, made of duralumin section. On the right in the canopy there is a hatch, intended for escaping the cockpit.

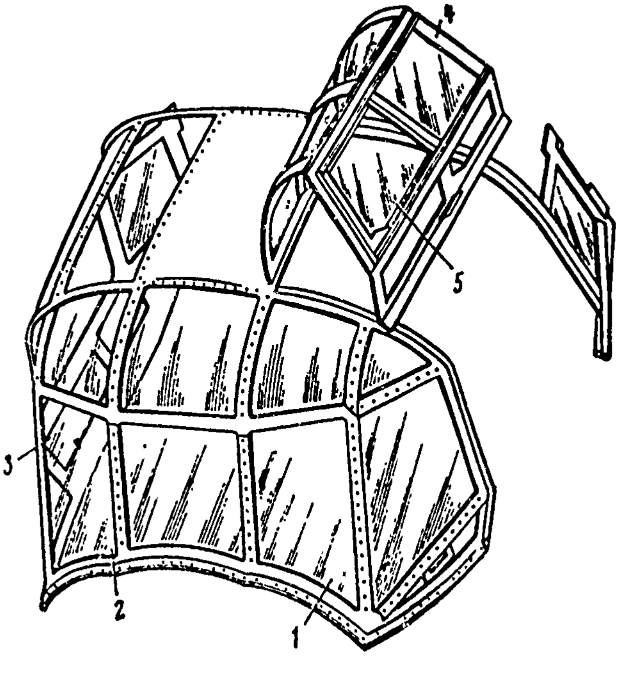

Fig. 219. The cockpit canopy: 1 – electric heating glasses; 2 – double glass, heated with warm air; 3 – emergency hatch; 4 – entrance door; 5 – window.

Tail surfaces. With increase in the span of the stabilizer its construction is changed. The framework of each half of the stabilizer (Fig. 220) consists of front and rear spars, 13 ribs and a leading edge with metal covering. The interspar section is broken down by three wire strip crosses. Along the axes of the main ribs Nos. 1, 6, 10 and 13 on the front and rear spars there are installed stamped fittings for attachment of the wire strips and ribs.

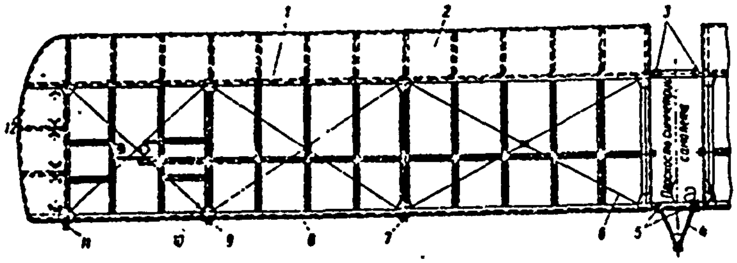

Fig. 220. The framework of the left cantilever of the stabilizer: 1 – front spar; 2 – leading edge of stabilizer; 3 – mounting bracket of the stabilizer to fuselage frame No. 23; 4 – central support of the elevator; 5 – mounting bracket of the stabilizer to frame No. 25; 6 – wire strip; 7, 9, 11 – hinge bracket of the elevator; 8 – rear spar; 10 – main rib No. 10; 12 – tip.

KEY: (a) Plane of symmetry of the aircraft.

On the lower plane of each cantilever of the stabilizer the section between ribs Nos. 10 and 13 is covered with metal sheet, to which the antenna is fastened and there is a hatch for access to it.

The landing gear is fixed in flight, is equipped with nitrogen-oil shock absorbers.

The nitrogen-oil shock absorber unlike the shock absorber of the An-2 aircraft has a lower sleeve with brake valve for direct and reverse motion, which is sealed along the rod and cylinder by rubber rings. The sleeve is screwed into the bottom end of the rod and has one central opening under a hollow bolt (diffuser) and four radial openings, similar to those in the valve-nut of the landing gear shock absorber of the An-2 aircraft.

The upper sleeve with stuffing box is screwed into the cylinder and serves as limiter and guide of the rod. The sleeve is kept from turning in the cylinder by two screws. Inside the rod is installed a diaphragm with packing rings.

Basic technical data of the shock absorber.

Working fluid................................	AMG-10
Volume of filled fluid, cm^3..................	1730 ± 20
Full stroke of rod, mm......................	246

The tail support is analogous to the tail wheel installation of the An-2 aircraft produced by the Polish People's Republic [PNR] (ПНР) (see Fig. 58) with a mechanism for locking the wheel fork in the neutral position. The construction of the shock absorber of the tail support is analogous to the construction of the shock absorber of the main landing gear strut.

Aircraft control. Single hand and foot control. The transmission to controls and ailerons is mixed and is accomplished by means of cables and rigid rods.

Landing gear brake control – pneumatic with rodding from each pedal to UP-25/2 reducing valve.

The power plant. On the An-2M aircraft there is installed the AV-2 propeller with metal blades, modernized cowlings and mounting frame of the engine to the fuselage, analogous to the cowlings and to the engine mount installed on An-2 aircraft of PNR production (see Fig. 93 and Fig. 95).

The oil system (Fig. 221) of the engine consists of MSh-8 oil pump, oil tank, 1106 air-oil cooler, drain cocks and lines.

To the oil system of the engine is connected the oil system of the gear box, which is equipped with a separate oil pump.

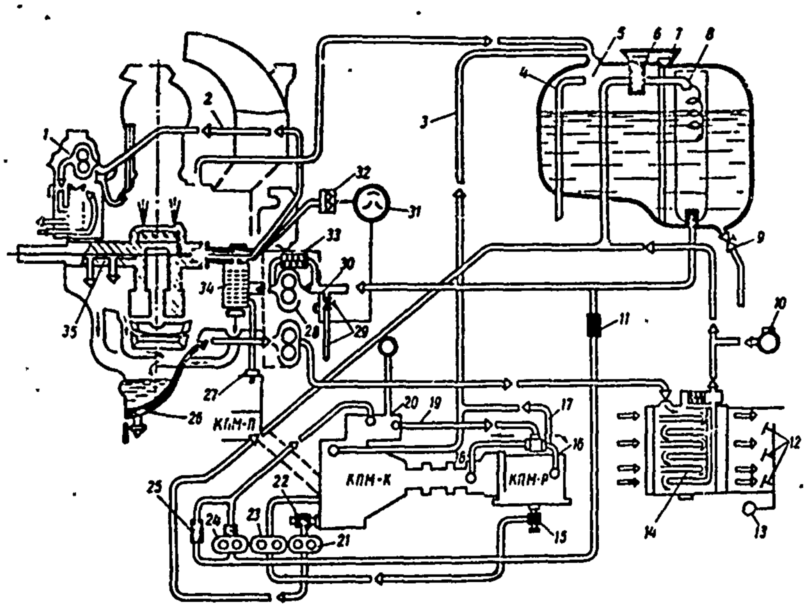

Fig. 221. Schematic diagram of the oil system: 1 – oil pump of the rpm governor; 2 – oil supply line to the rpm governor; 3 – breather lines of the engine and gear box; 4 – drain pipe; 5 – oil tank; 6 – filler neck with filter; 7 – level gauge; 8 – circulating sump; 9 – drain cock and drain tube; 10 – oil dilution valve; 11 – gauze filter; 12 – flaps of the oil cooler duct; 13 – transmitter of UZP-48 oil cooler gate position indicator; 14 – oil cooler; 15 – oil filter and drain cock of reduction gear; 16 – oil feed to the gearing of reduction gear; 17 – breather line of KPM-R reduction gear; 18 – oil feed to slide valve of reduction gear; 19 – oil feed to KPM-R reduction gear; 20 – fitting for the measurement of oil pressure; 21, 23 – large and small scavenging stages of the oil pump of the gear box; 22 – drain cock and oil filter; 24 – pressure stage of oil pump; 25 – reducing valve; 26 – oil sump of the engine and drain cock; 27 – fitting for supply of oil to KPM-P reducer; 28 – scavenging and pressure stages of the engine oil pump; 29 – oil drain cock and tube from the oil system; 30 – P-1 transmitter of oil temperature at the engine inlet; 31 – UKZ-1 indicator of temperature and pressure of oil at the engine inlet; 32 – P-15B transmitter of the oil pressure at the engine inlet; 33 – reducing valve; 34 – MFM-25 plate filter; 35 – crankshaft.

Designation: КПМ-П = KPM-P; КПМ-К = KPM-K; КПМ-Р = KPM-R.

The KPM gear box — unit designed for power take-off from the ASh-62M engine to the drives of one generator, operating the agricultural equipment and aircraft systems, and the conditioner (pump). The KPM unit consists of KPM-P reducer, inclined shaft, KPM-K gear box, horizontal shaft, KPM-R reduction gear, lubrication and breather system. The gear box is installed in the forward section of the fuselage under the cockpit floor between frames Nos. 1 and 4. For attachment of the box between frames Nos. 2 and 3 there are two stringers. The gear box is attached with four joints with bushing-type rubber dampers by means of 30KhGSA steel bolts 16 mm in diameter.

Pneumatic system (Fig. 222) is used for braking the landing gear wheels (skis), locking the fork of the tail support and control of the agricultural equipment. It consists of the main system and the control system of the agricultural equipment.

The main system includes the network of pressure sources and the lines of wheel (skis) braking and tail support locking. The control system of the agricultural equipment includes the dusting and spraying control lines. Both systems are connected together through 219K stop cock and IL611-150-35 reducing valve, which lowers the pressure in the control system of agricultural equipment. The operating pressure of air in the main system — 20-50 kgf/cm^2, in the agricultural equipment control system — 25-35 kgf/cm^2. At the indicated pressures there is ensured the normal operation of all users.

In the system there are installed two M5810-0 aircraft bottles for compressed air with capacity 8 l each. One of them is installed in the main system, the other — in the control system of the agricultural equipment.

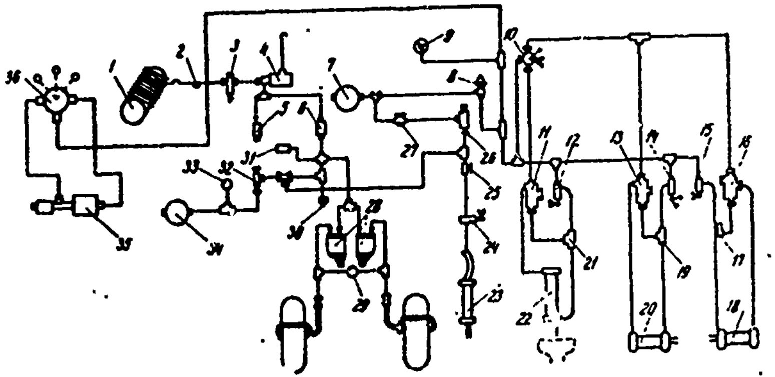

Fig. 222. Schematic diagram of the pneumatic system: 1 – AK-50M compressor; 2 – tee with fitting; 3 – T-9901 filter; 4 – AD-50 automatic pressure control; 5 – aircraft charge fitting; 6 – direct-flow filter; 7 – compressed air bottle of the agricultural equipment control system; 8 – cut-off valve; 9 – MV-80M line manometer; 10 – cock for feeding compressed air into the agricultural equipment control line; 11, 13, 16 – release valves; 12, 14, 15 – electric-air valves EK-69; 17, 19, 21 – throttle; 18, 20 – pneumatic control cylinders of agricultural equipment; 22 – pneumatic cylinder of the gate of the measuring hopper of the tank for chemicals; 23 – pneumatic cylinder for locking the tail support; 24 – electromagnetic valve; 25 – aircraft fitting for recharging the shock absorber and pneumatic tires of the wheel from the aircraft pneumatic system; 26 – 219K stop cock; 27 – reduction gear; 28 – brake reducing valves; 29 – MV-12 manometer; 30 – fitting; 31 – safety valve; 32 – 219K stop cock; 33 – MV-80M manometer; 34 – compressed air bottle of the main system; 35 – pneumatic cylinder; 36 – pneumatic stopcock.